



US006665089B1

(12) **United States Patent**  
Austin et al.

(10) **Patent No.:** **US 6,665,089 B1**  
(45) **Date of Patent:** **Dec. 16, 2003**

(54) **CONTROL SYSTEM AND METHOD FOR A PORTABLE ELECTRONIC PRINTER**

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/289,243**

(22) Filed: **Apr. 9, 1999**

#### Related U.S. Application Data

(60) Provisional application No. 60/081,412, filed on Apr. 10, 1998, provisional application No. 60/081,372, filed on Apr. 10, 1998, provisional application No. 60/081,381, filed on Apr. 10, 1998, and provisional application No. 60/084,435, filed on May 6, 1998.

(51) Int. Cl.<sup>7</sup> ..... **G06F 15/00**; B41J 29/38;  
B41J 29/393; G01D 9/00; G01D 15/66

(52) U.S. Cl. .... **358/1.18**; 358/1.18; 358/1.1;  
358/1.9; 347/14; 347/17; 347/19; 346/1.1;  
346/33; 346/140

(58) Field of Search ..... 358/1.15-1.18,  
358/14, 17, 19; 347/14-17, 19

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*Primary Examiner*—Edward Coles

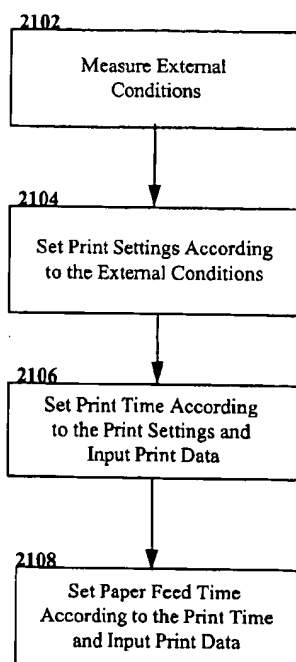
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(57) **ABSTRACT**

A control system for a portable electronic printer is disclosed. The control system implements a method for performing a self-test of the hardware of a portable electronic printer, a method for monitoring the hardware of a portable electronic printer for a failure, a method for diagnosing a portable electronic printer, a method for booting a portable electronic printer having both volatile and non-volatile memory, a method for controlling the printing of data received from a serial transmission line whereby printing may be canceled, a method for controlling a printing system such that code or data in the printing system may be updated, a method of verifying a downloaded file in a printing system, a method for determining a communications protocol in a printing system, and a method for controlling communications in a printing system during a diagnostic routine.

**35 Claims, 22 Drawing Sheets**



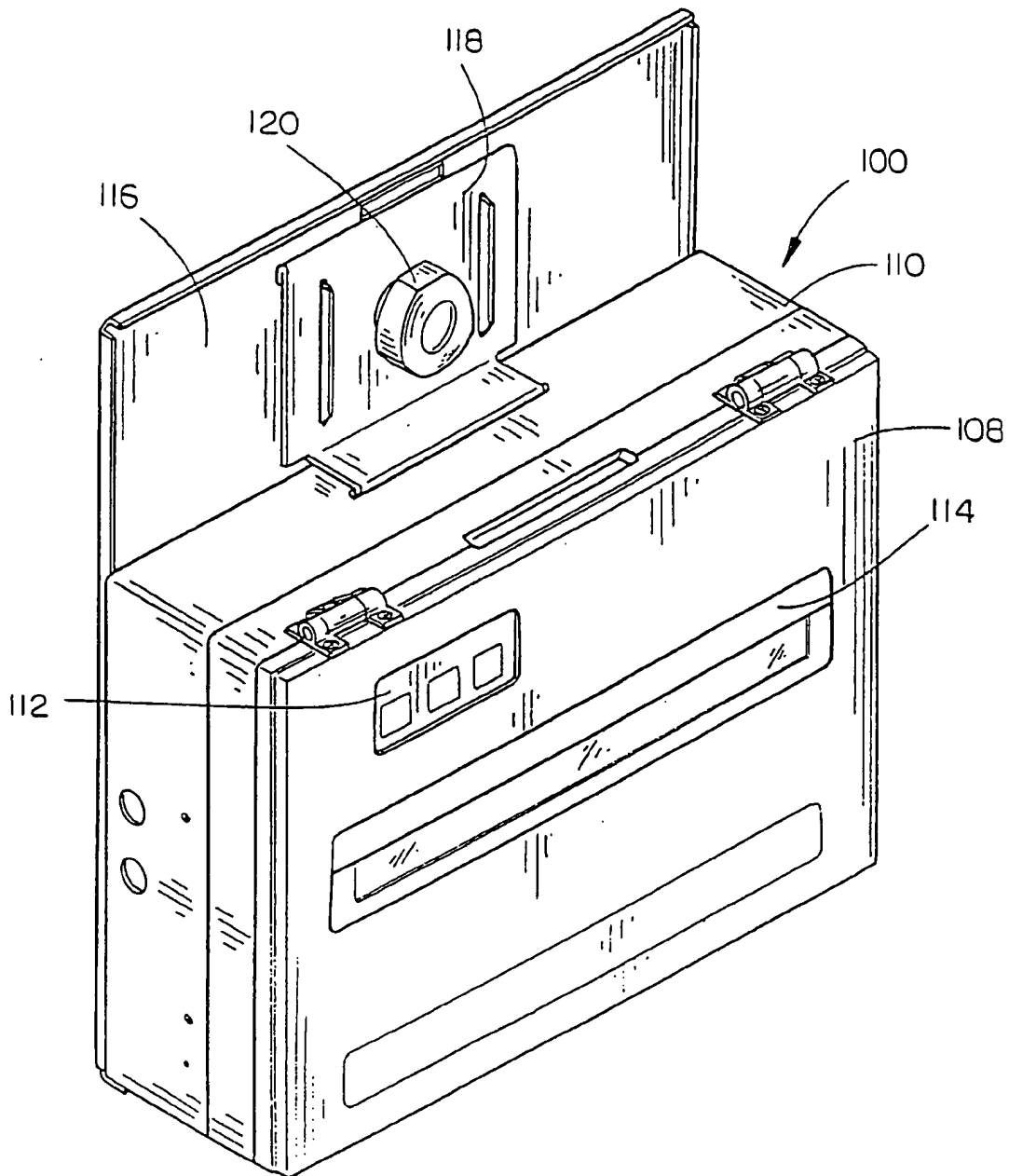


FIG. 1

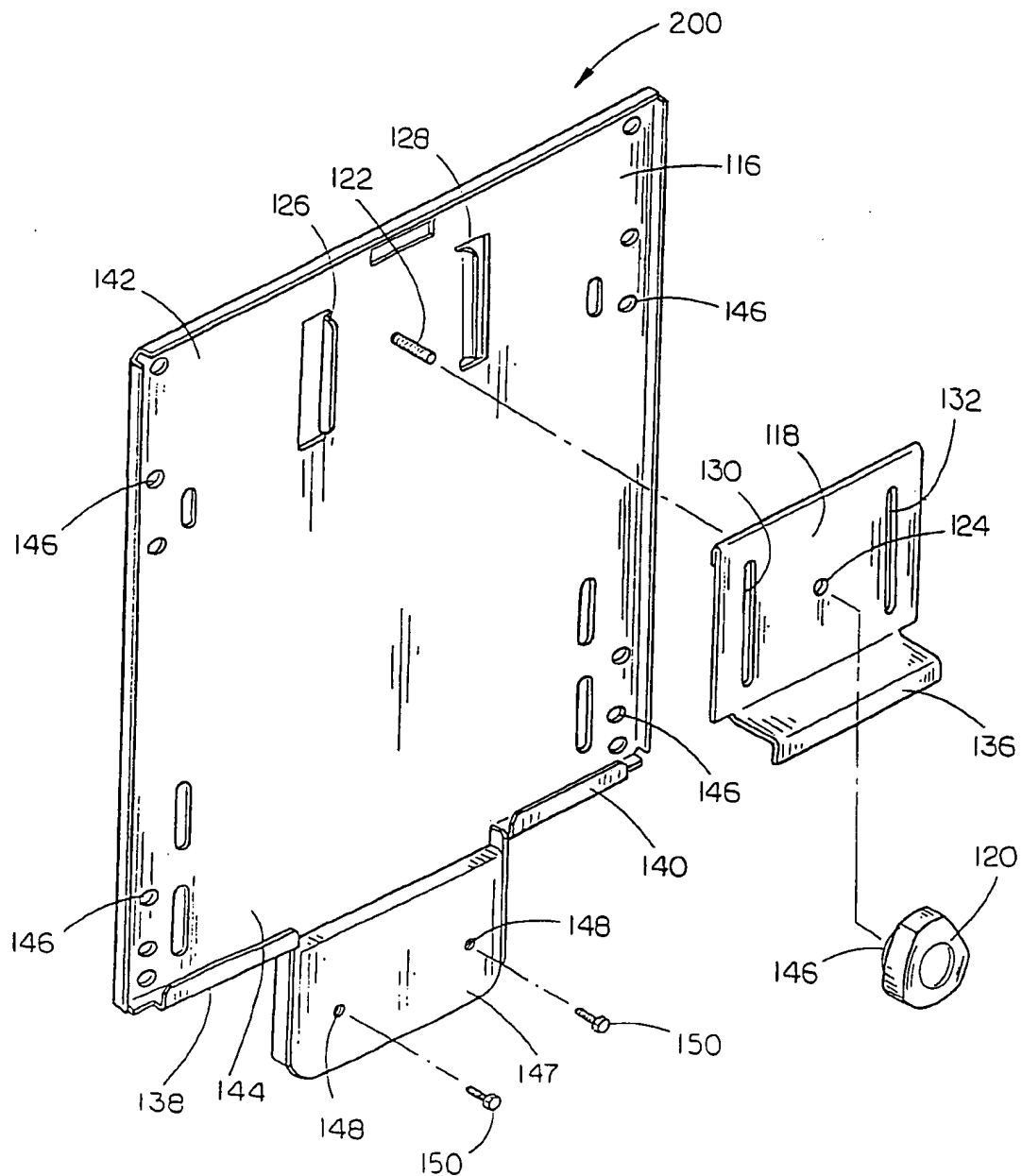


FIG. 2

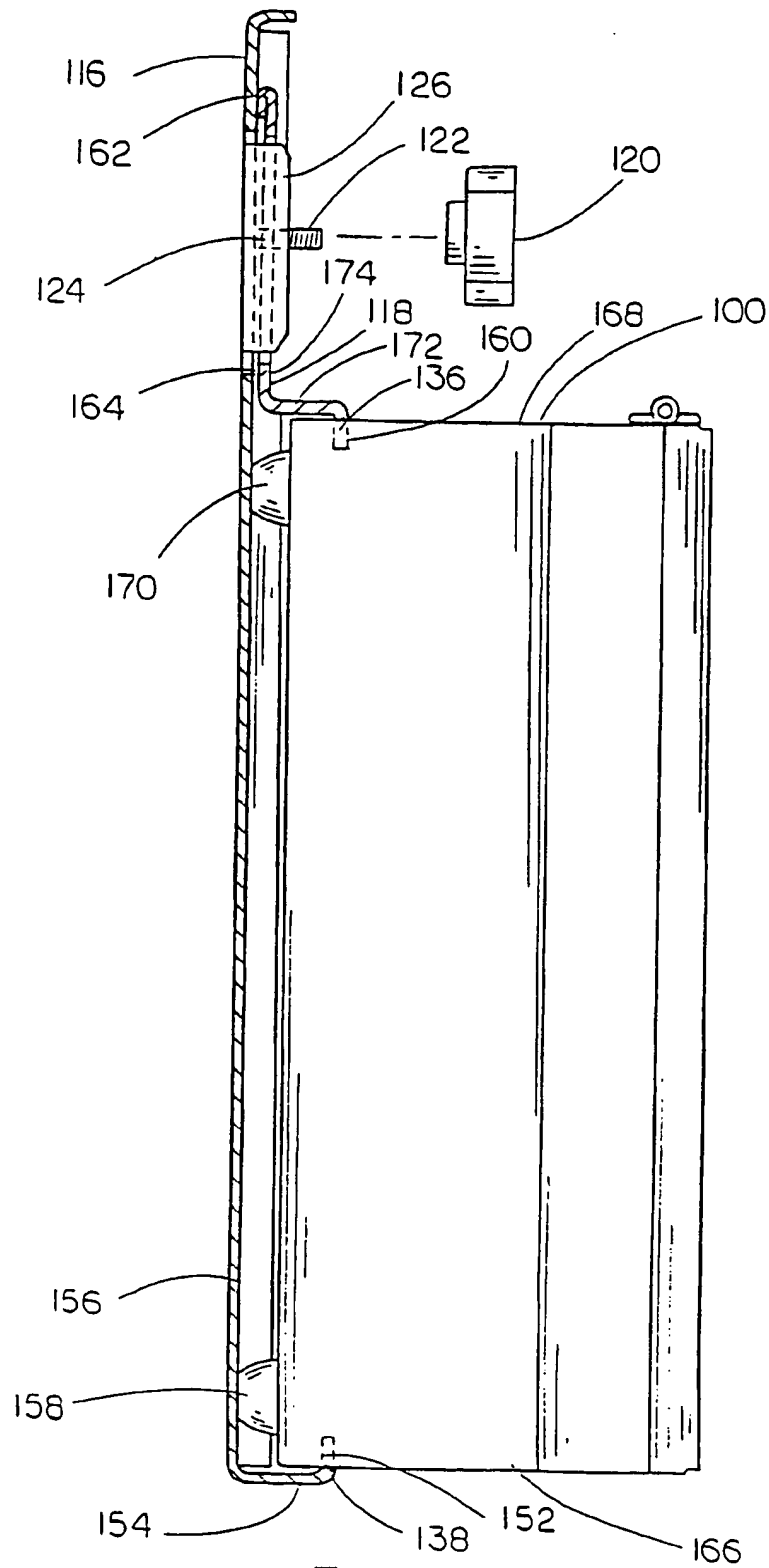


FIG 3

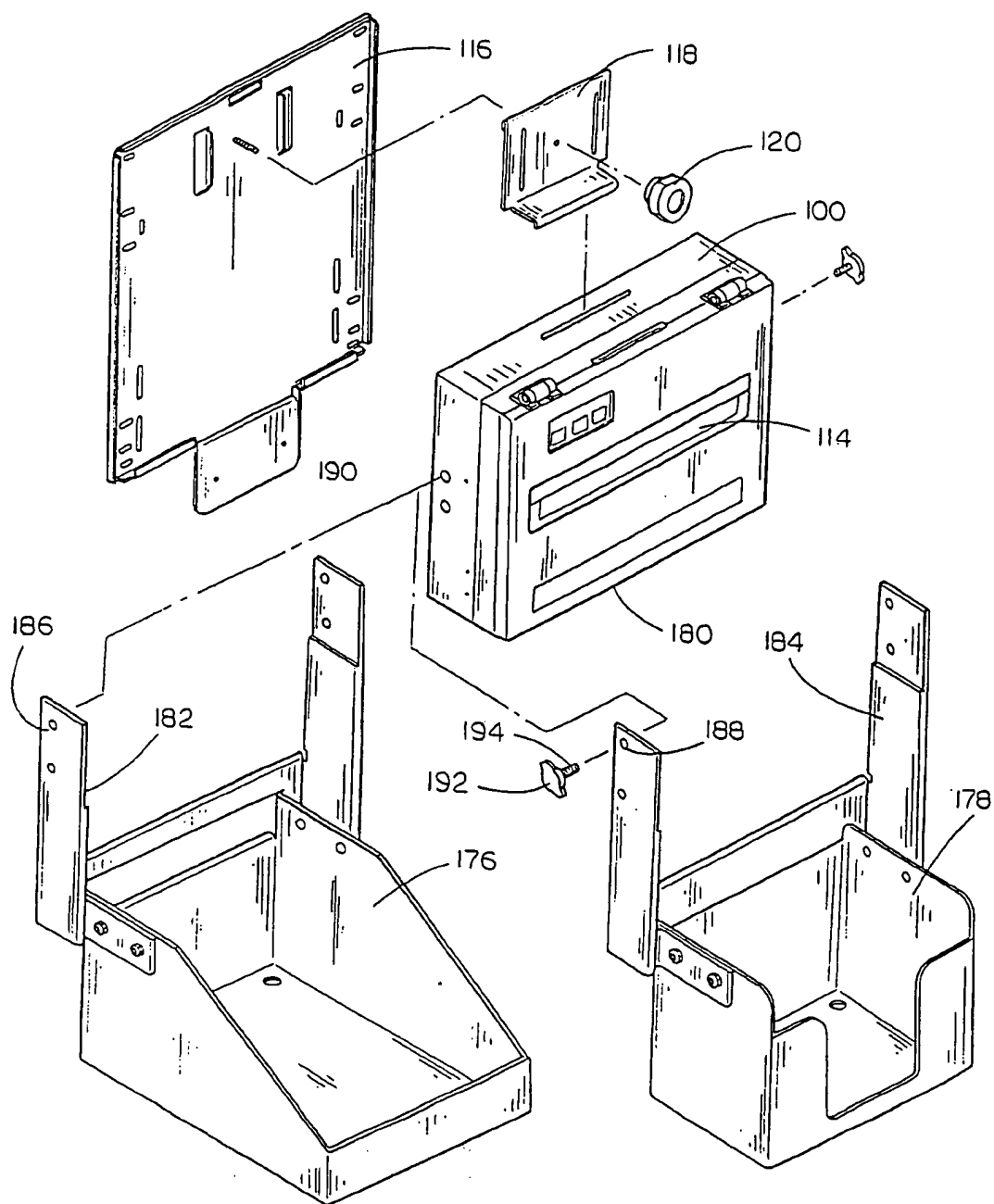


FIG. 4

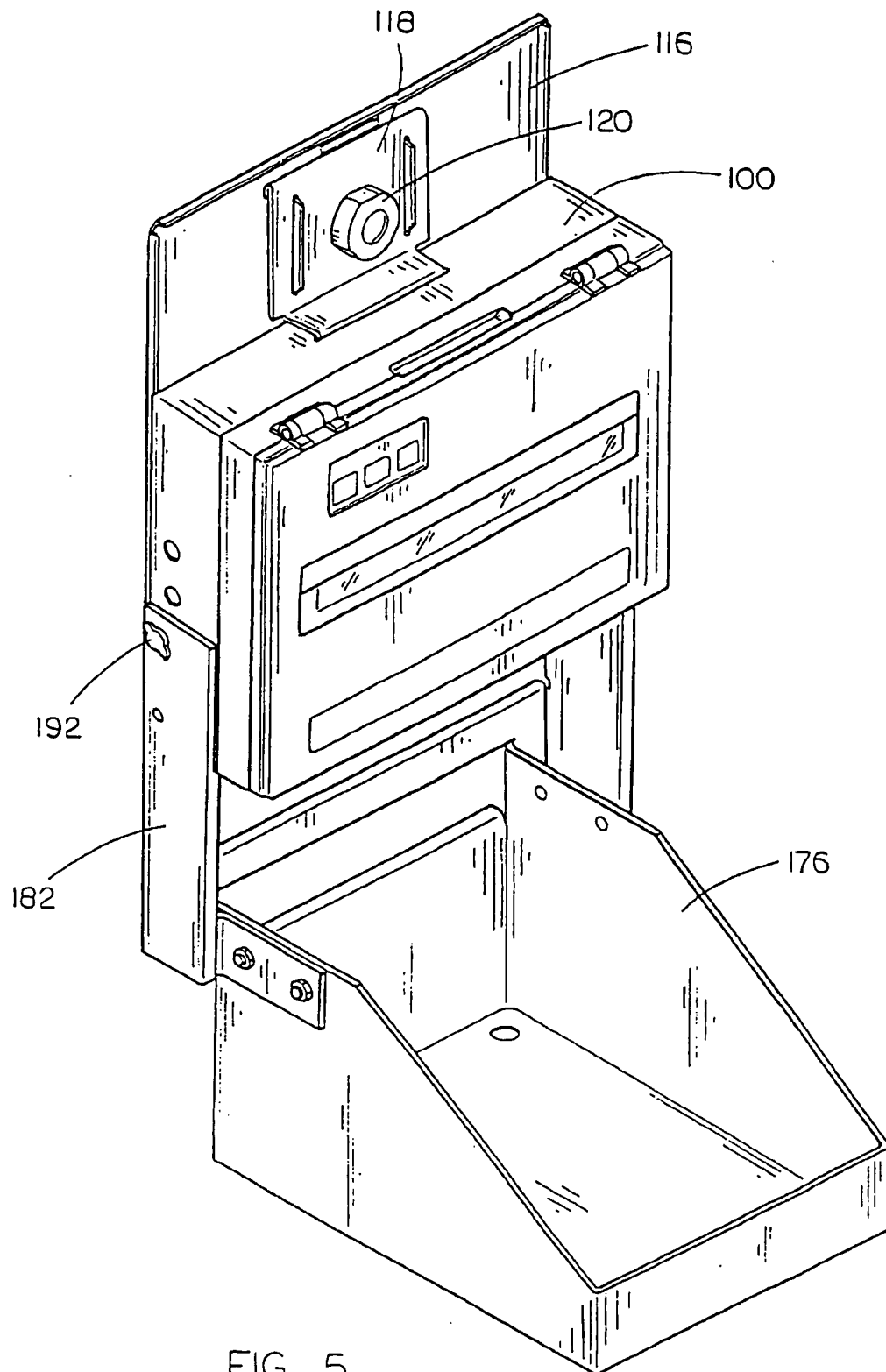


FIG. 5

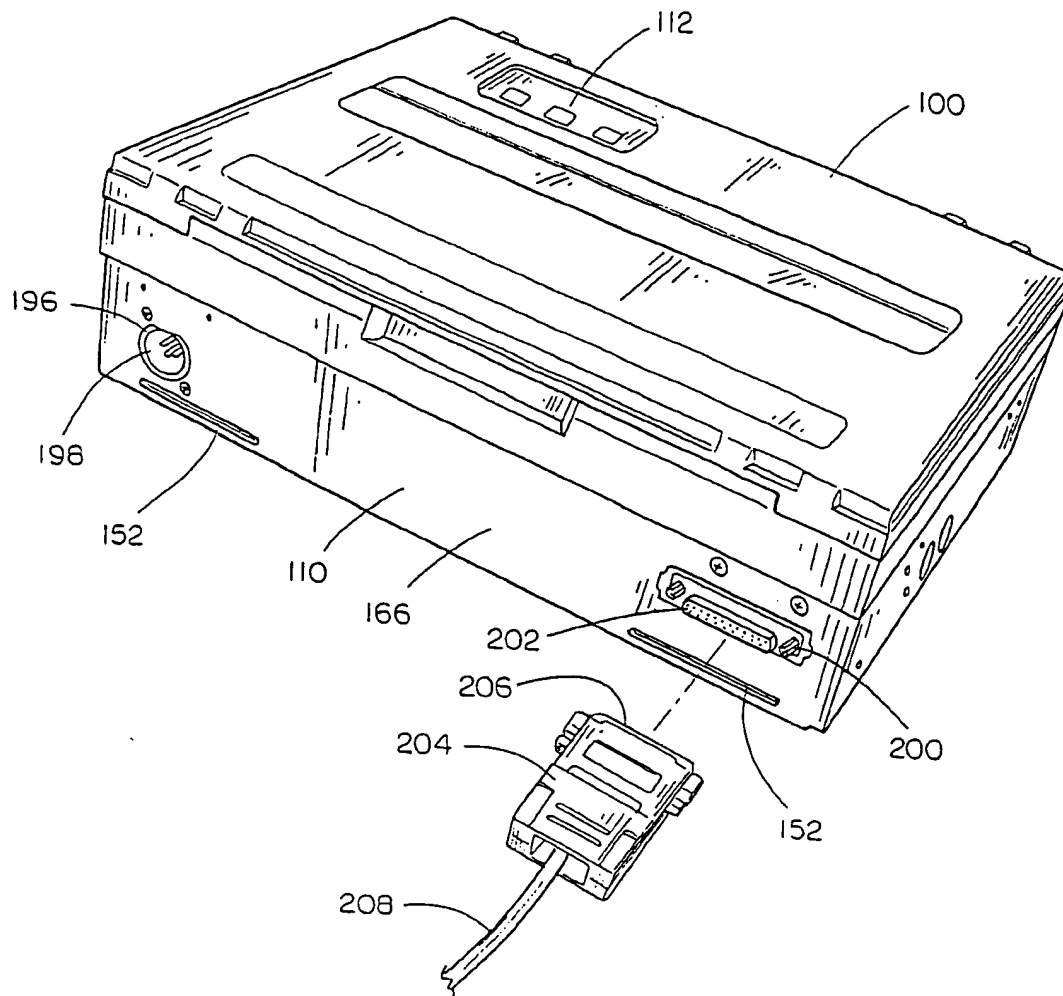


FIG. 6

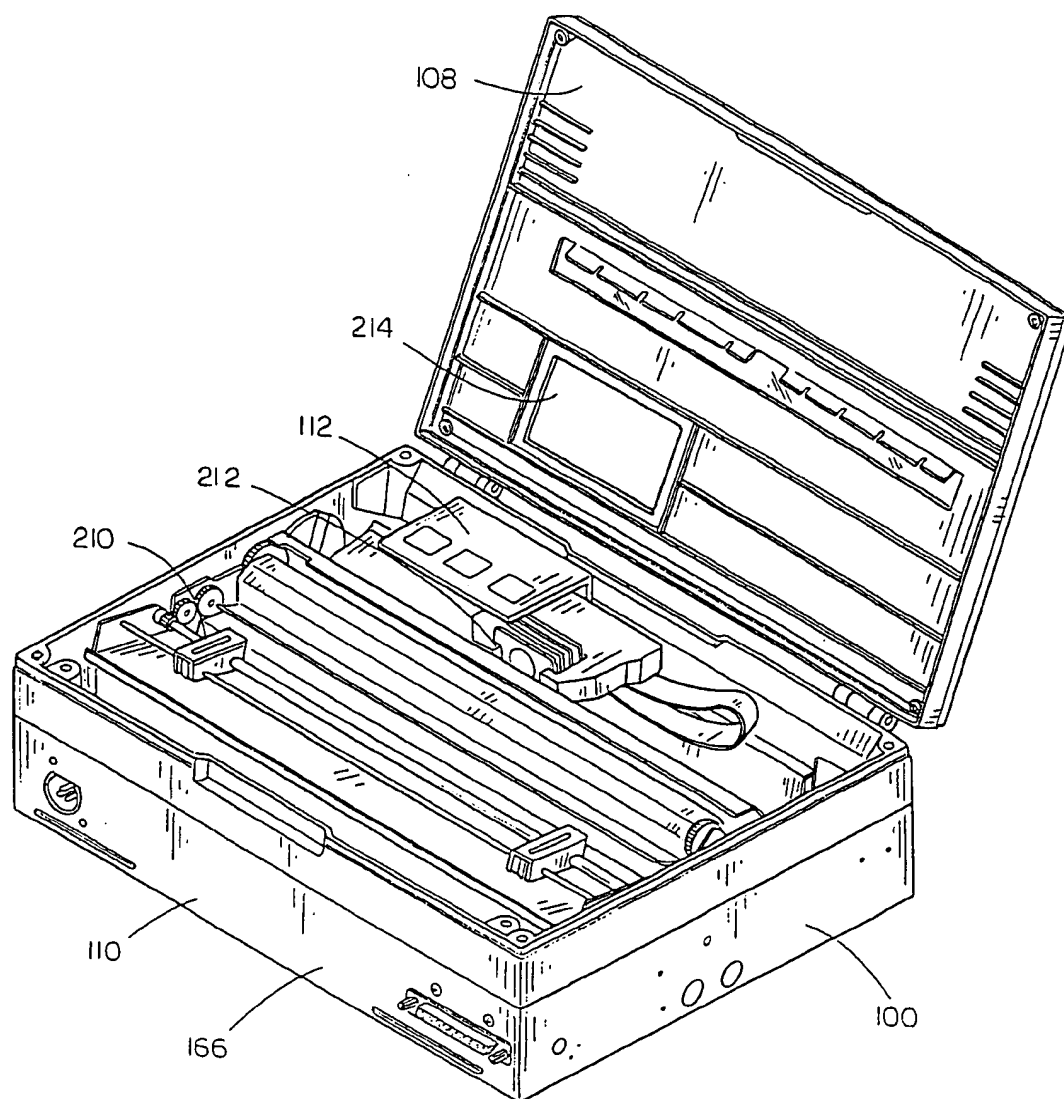
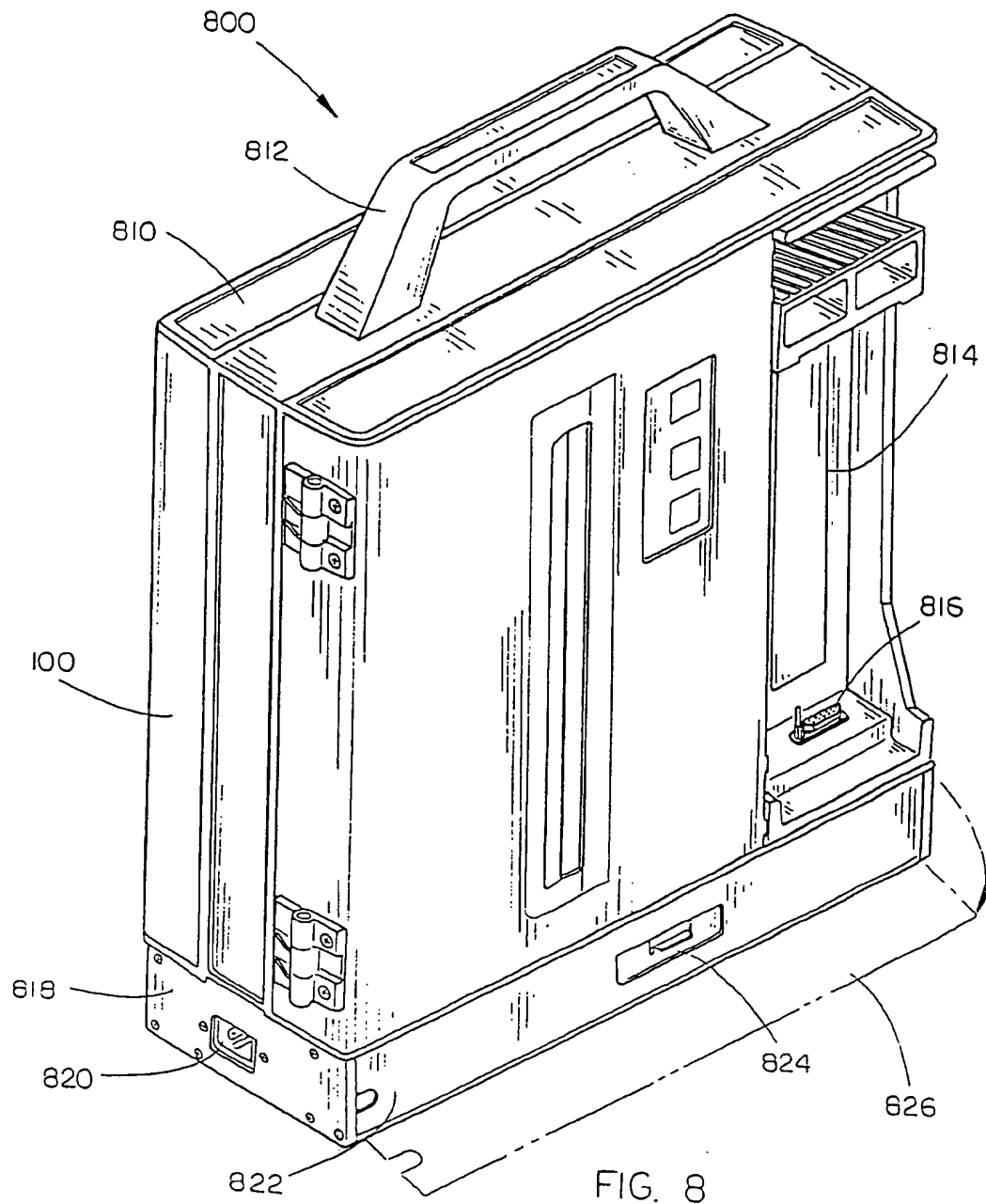


FIG. 7





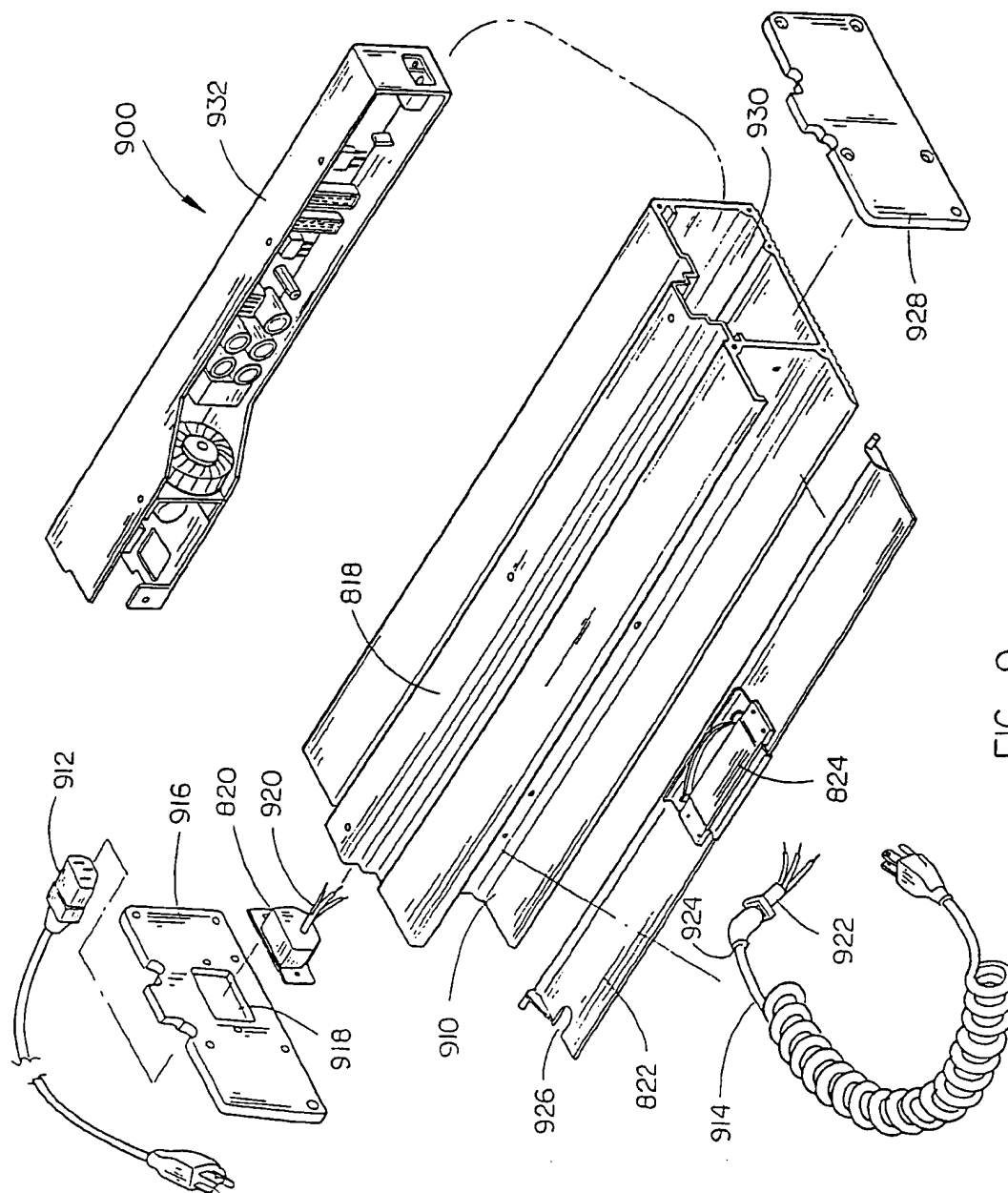


Fig. 9

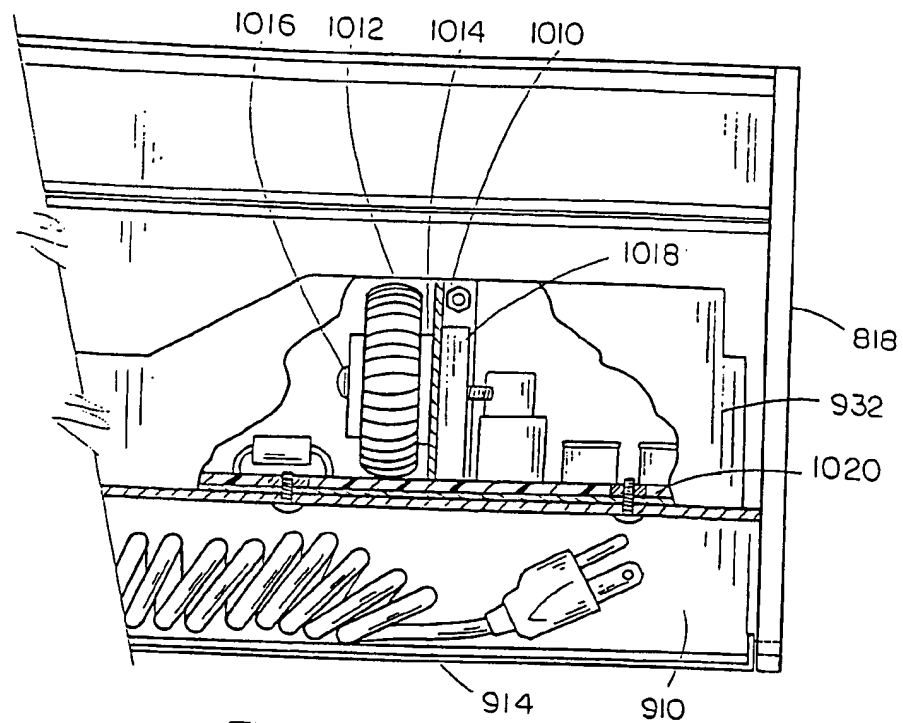


FIG. 10

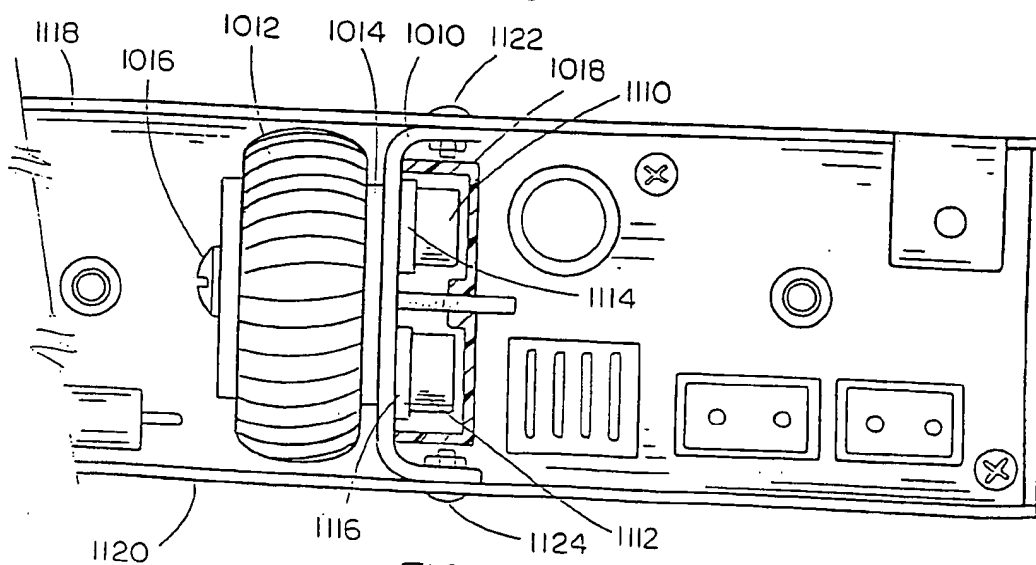


FIG. 11

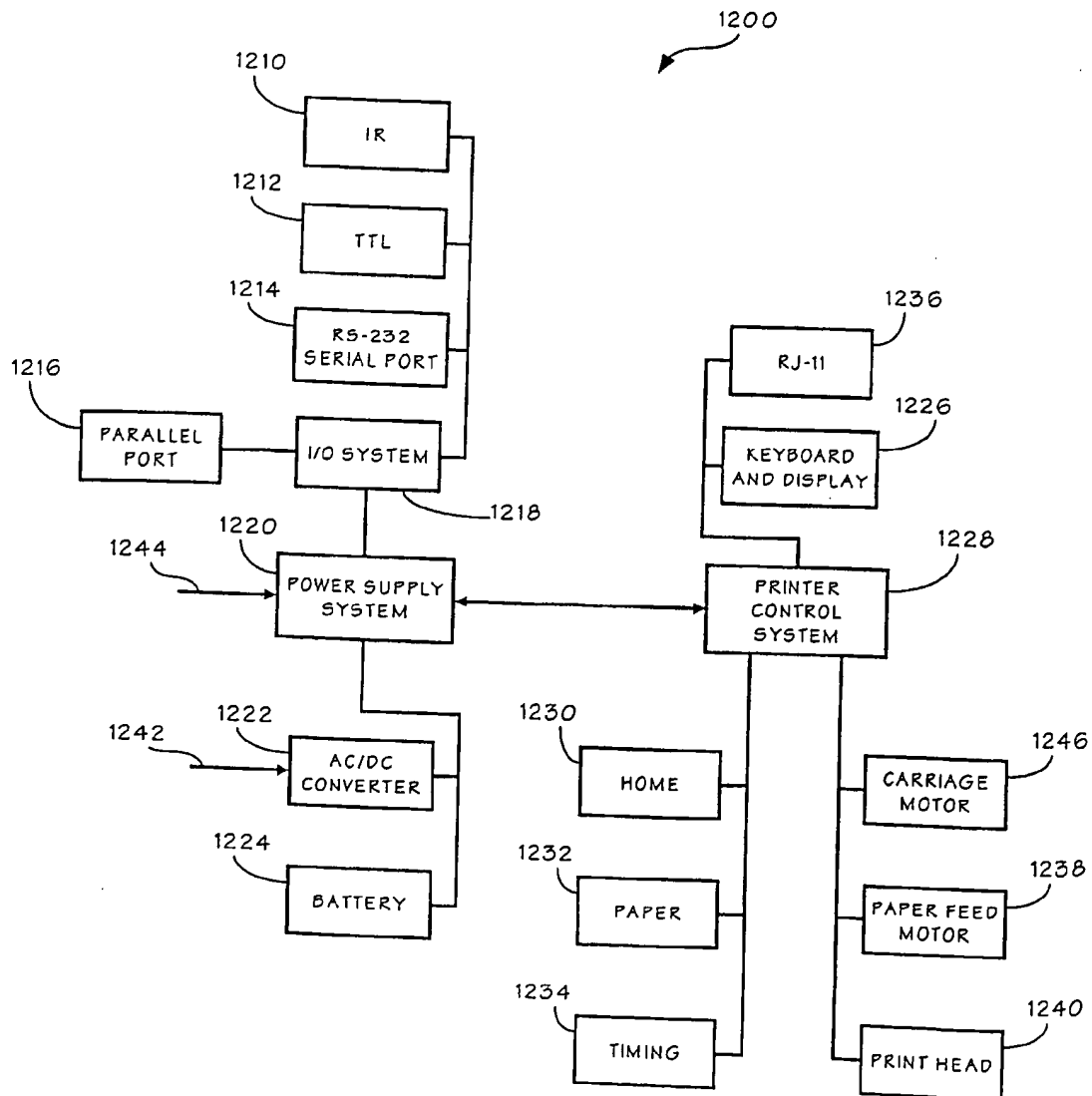


FIG. 12

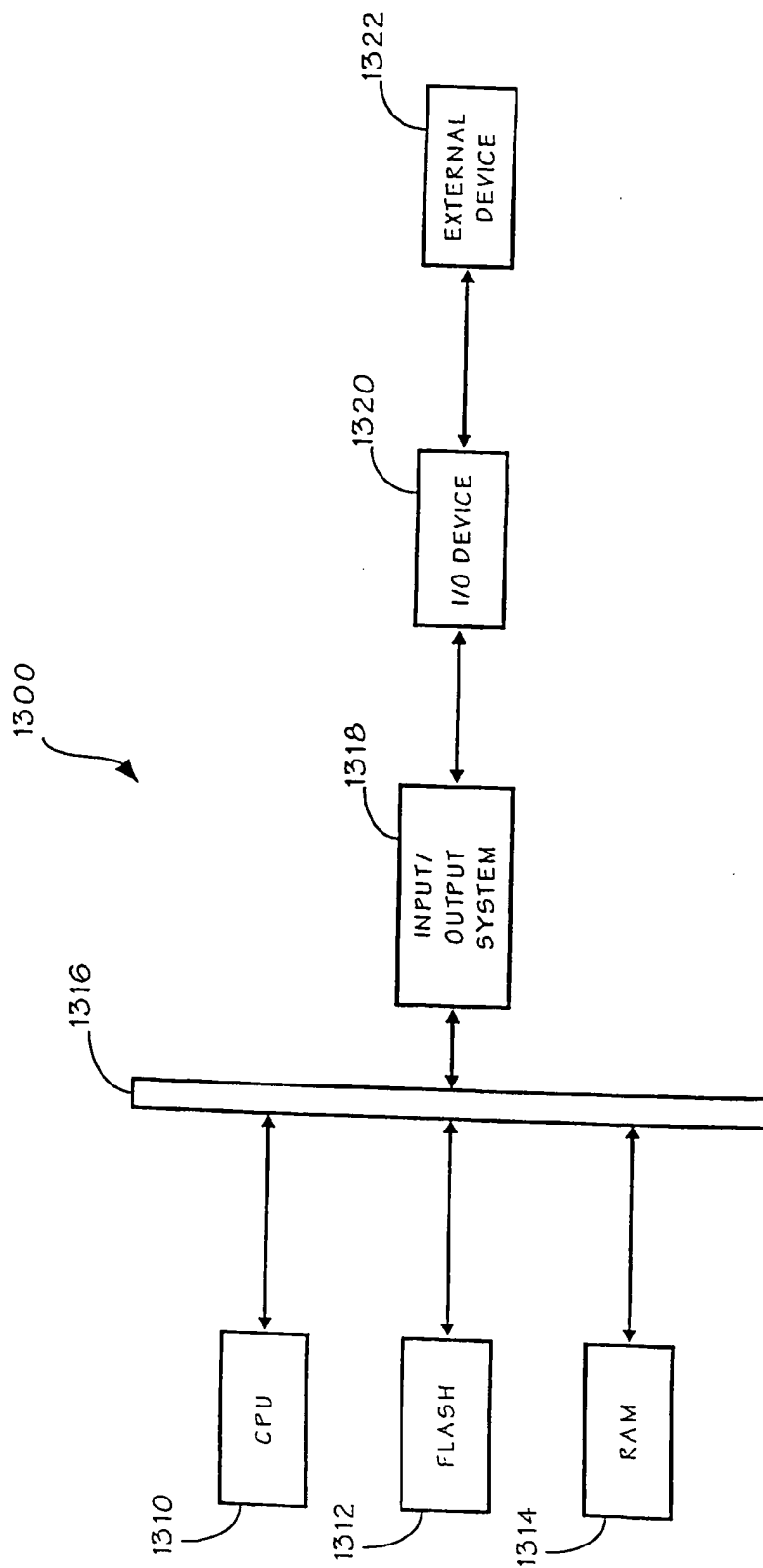


FIG. 13

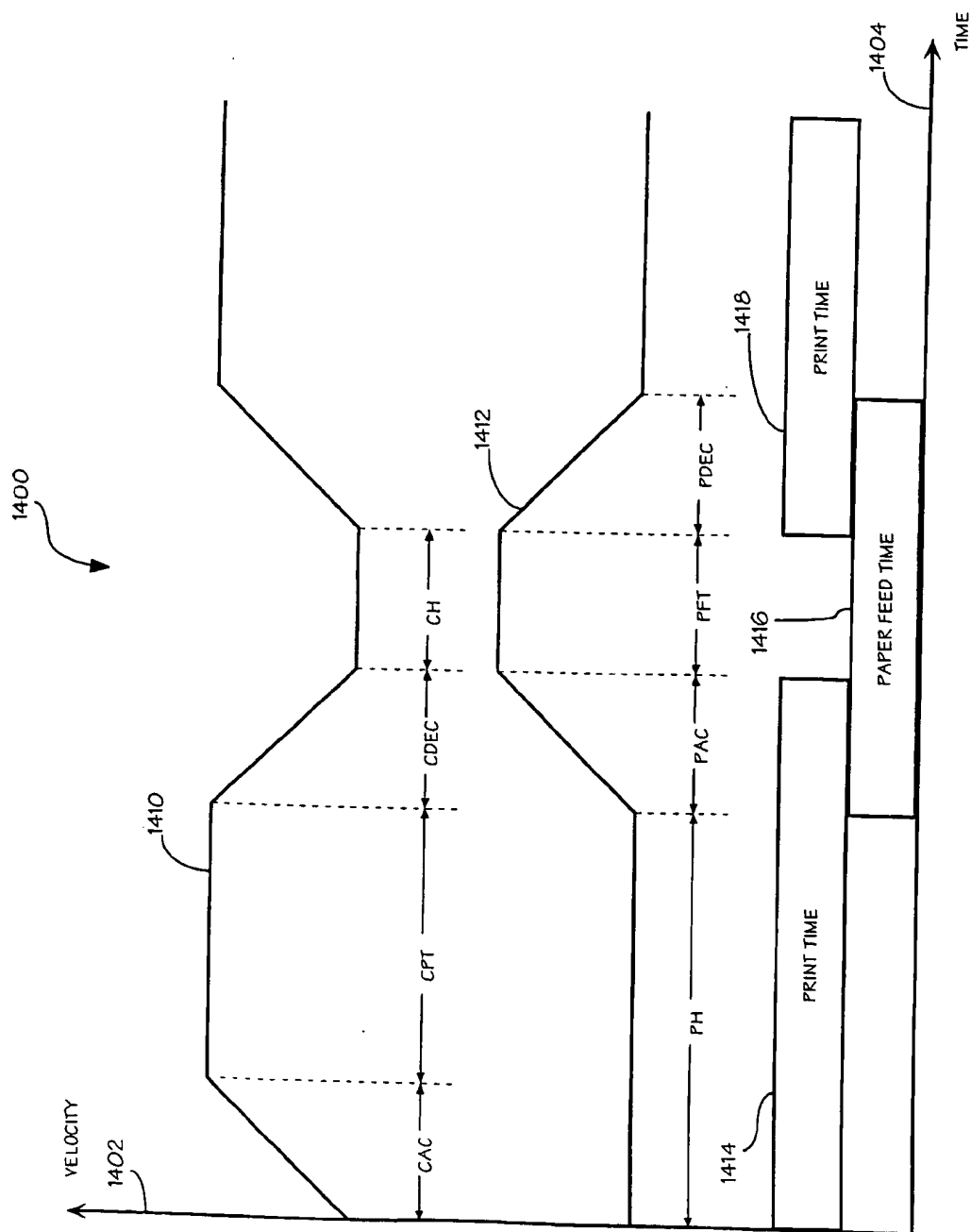


FIG. 14

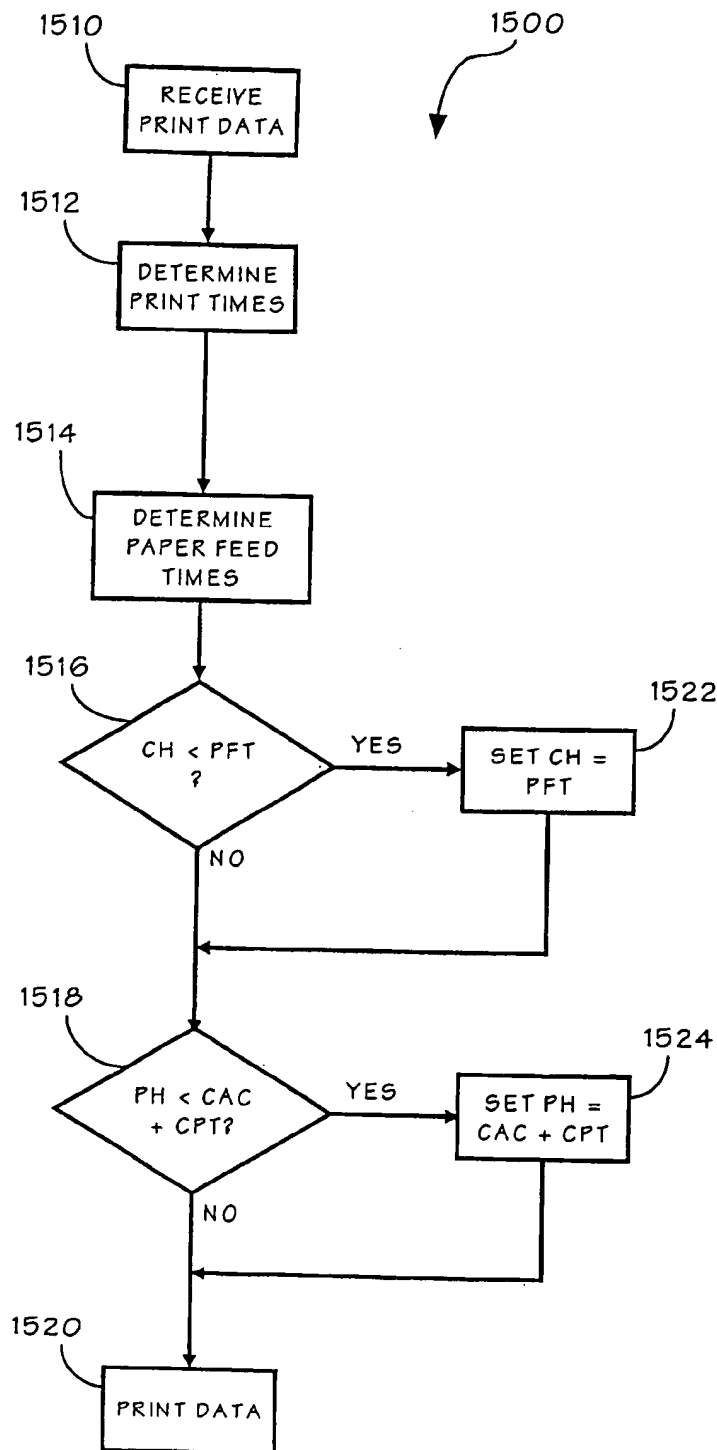


FIG. 15

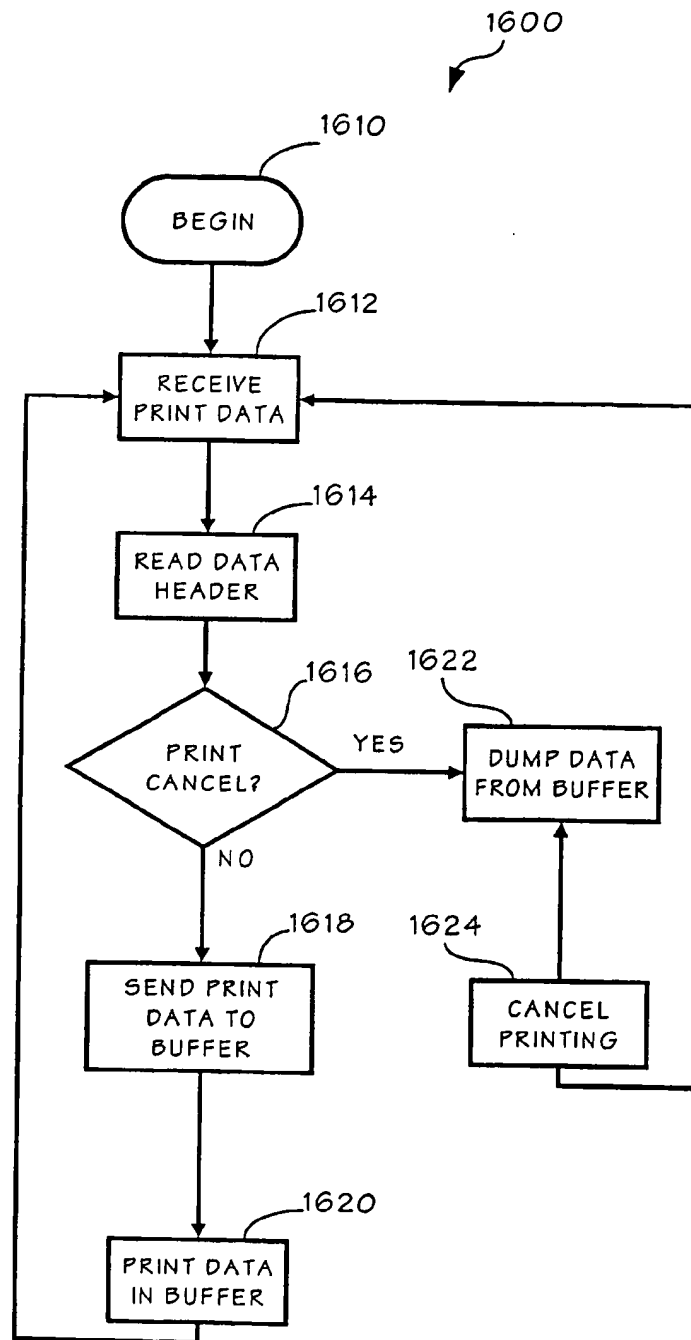


FIG. 16



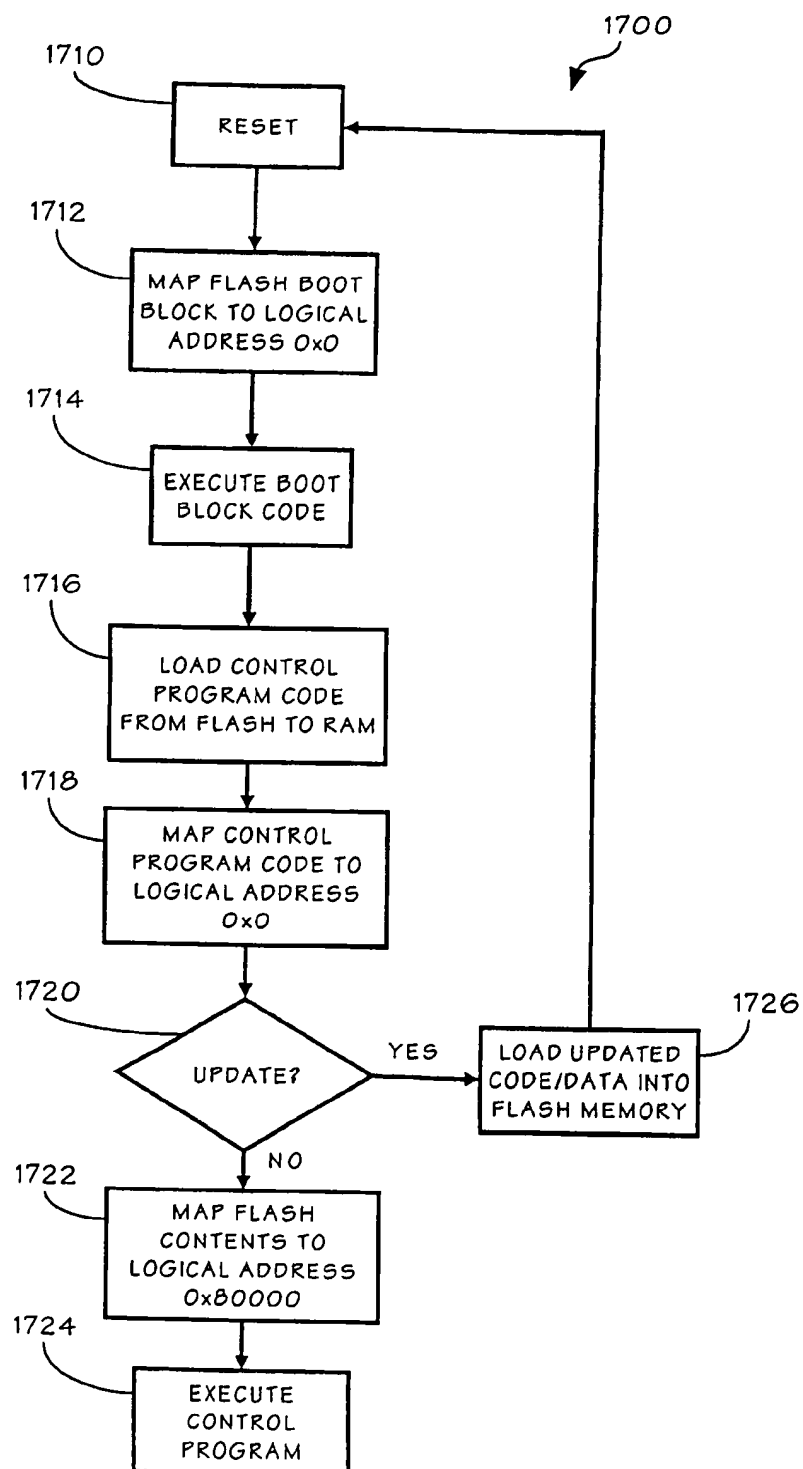


FIG. 17

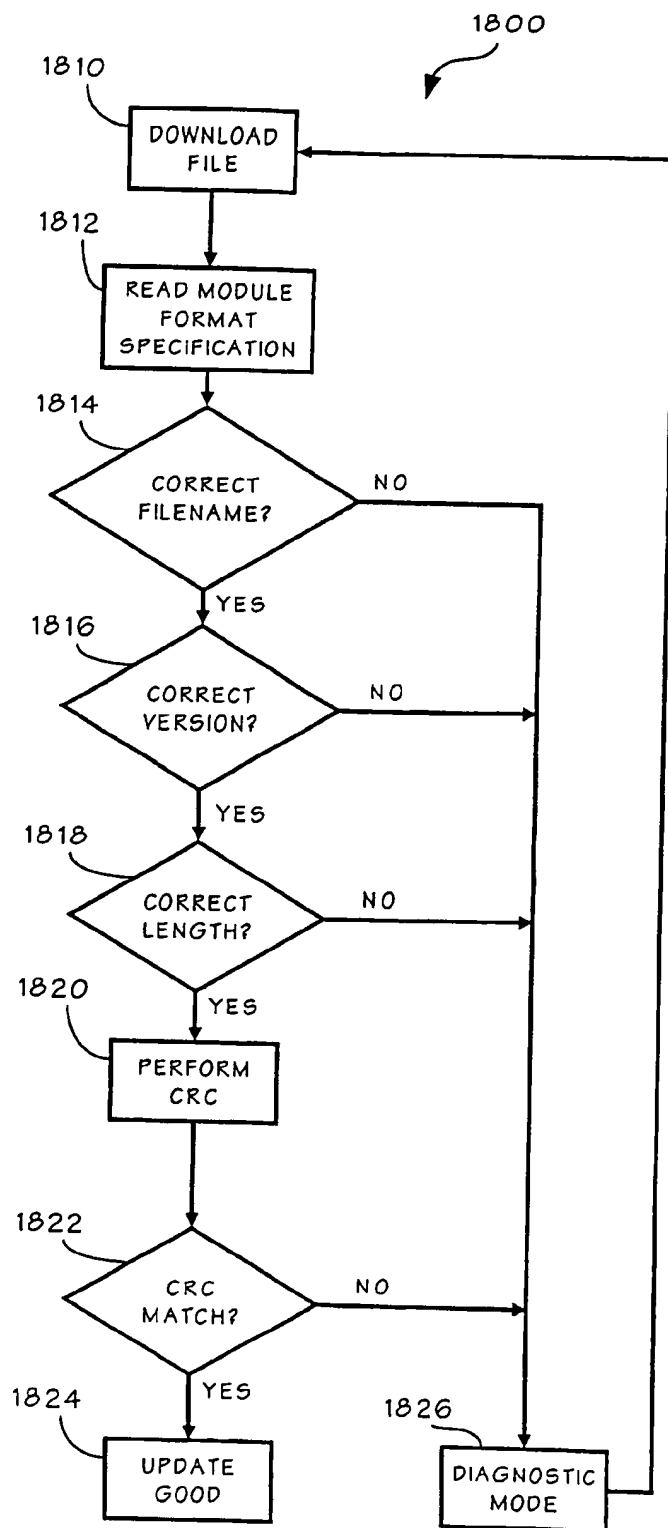


FIG. 18

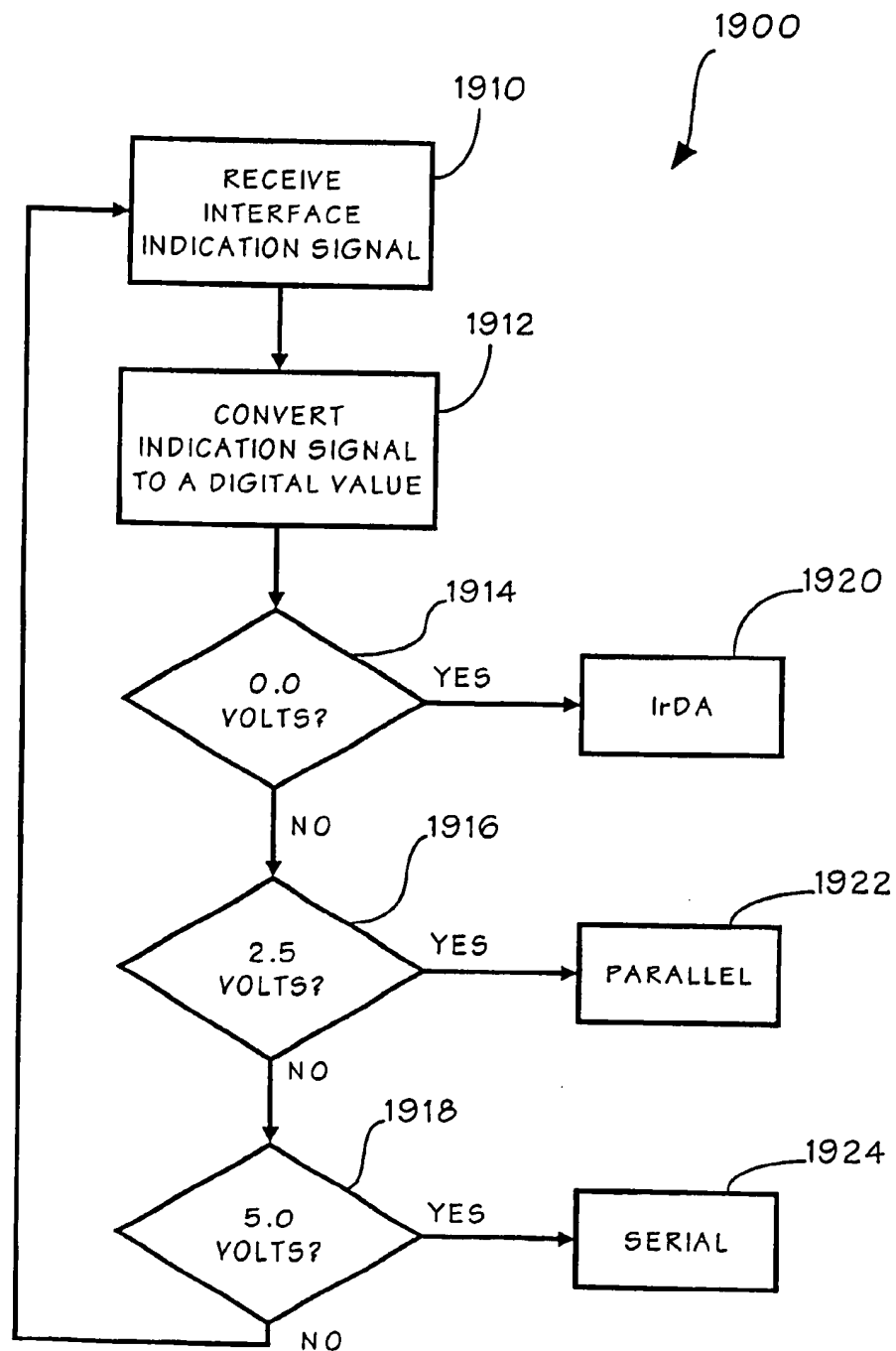


FIG. 19

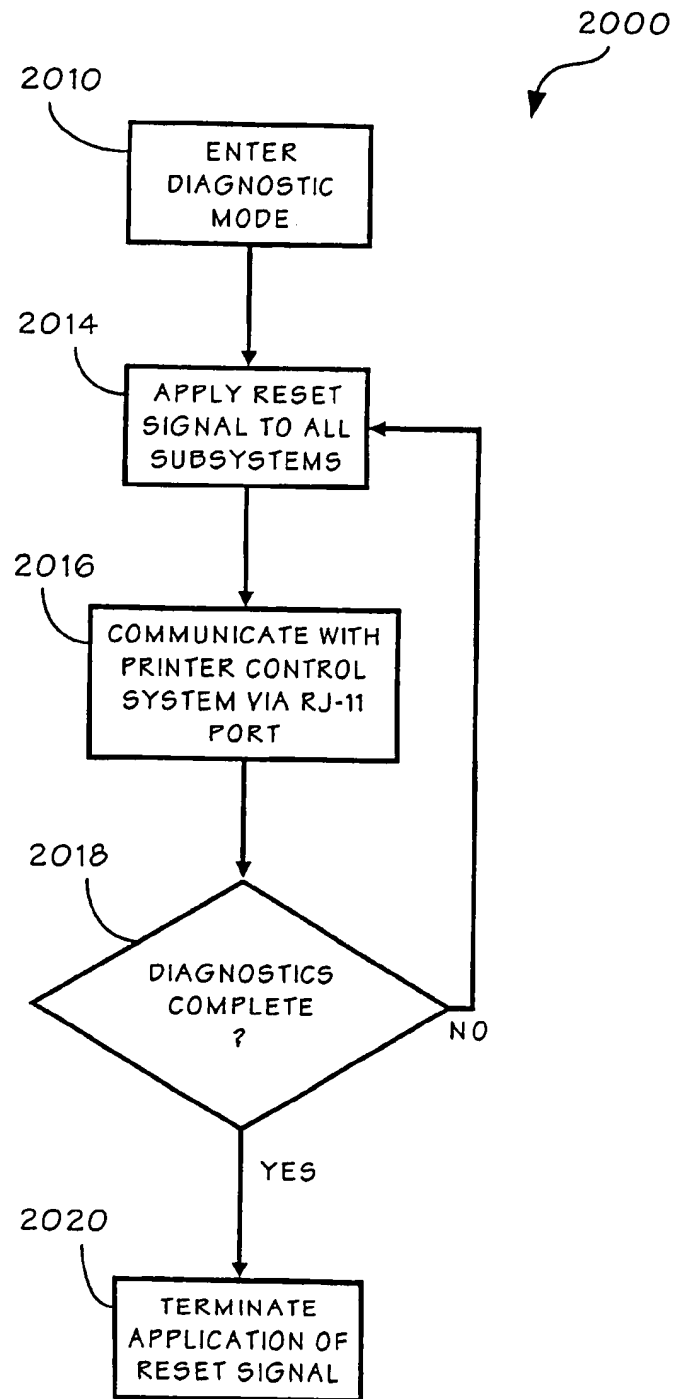


FIG. 20

FIG. 21

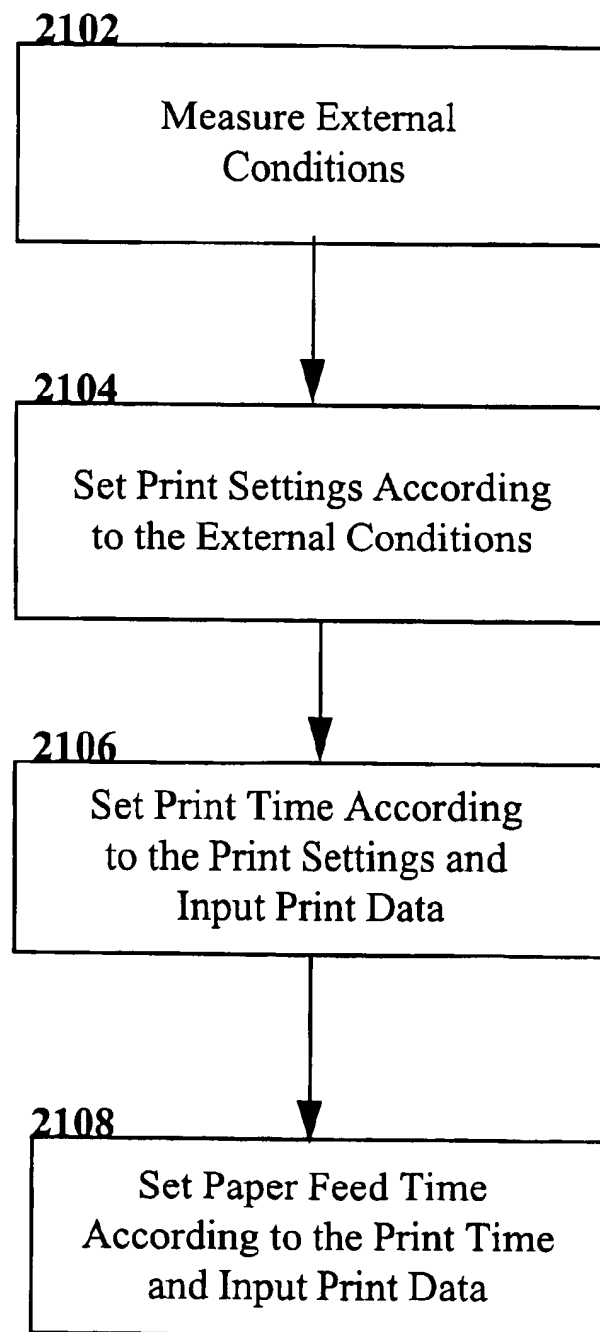


FIG. 22

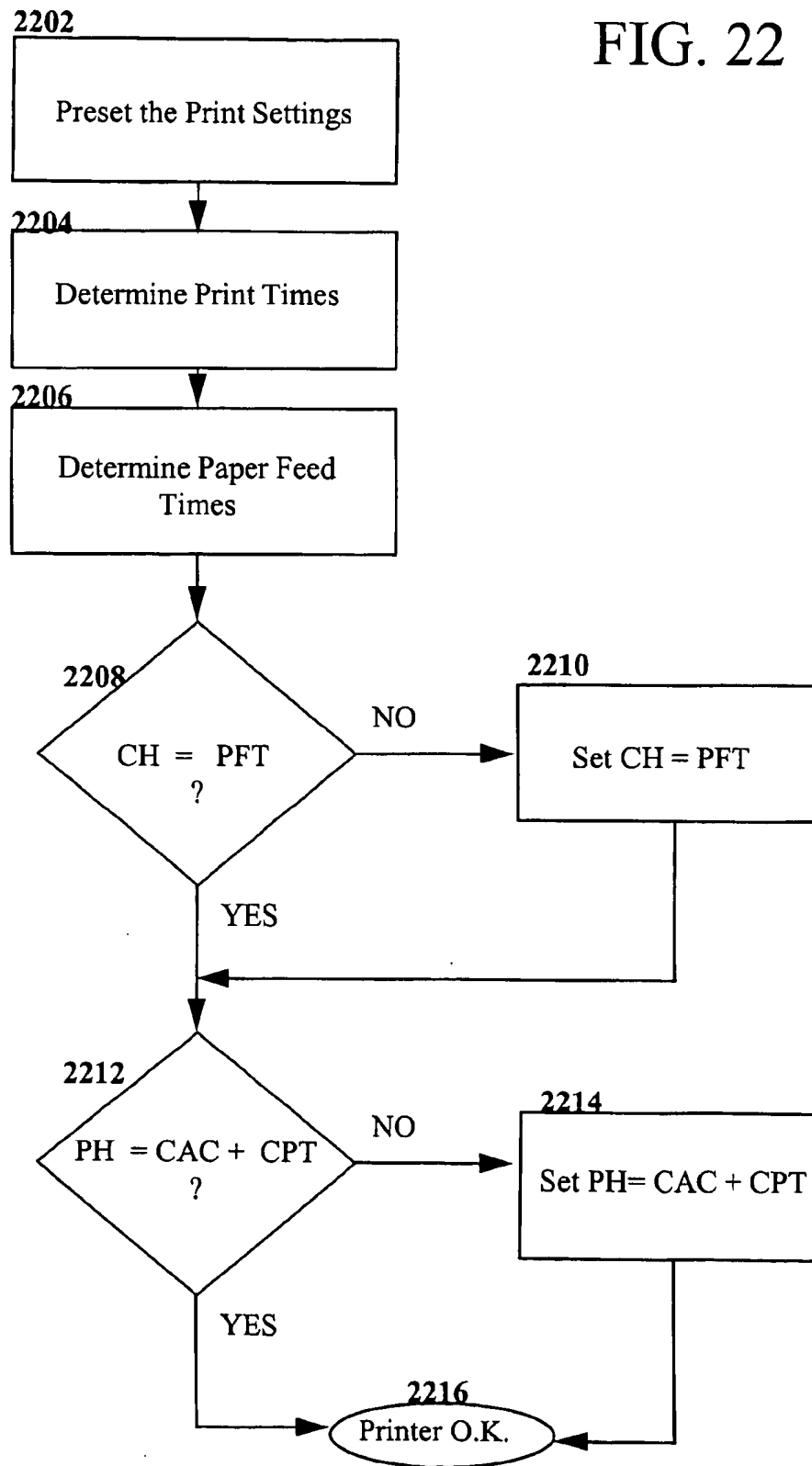
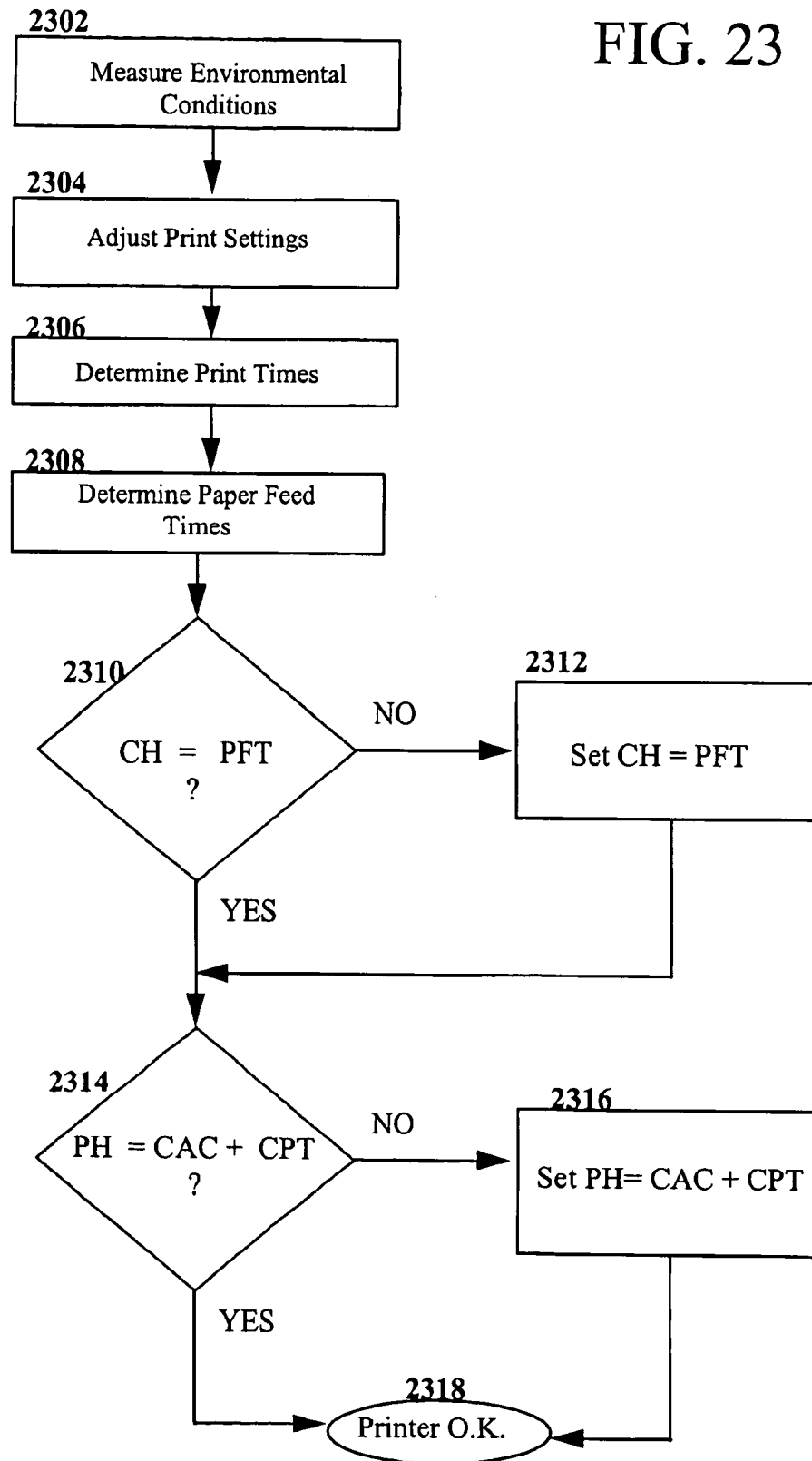


FIG. 23



1

## CONTROL SYSTEM AND METHOD FOR A PORTABLE ELECTRONIC PRINTER

### CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. 119 to the following U.S. provisional patent applications:

Provisional Application No. 60/081,412, filed Apr. 10, 1998,

Provisional Application No. 60/081,372, filed Apr. 10, 1998,

Provisional Application No. 60/081,381, filed Apr. 10, 1998, and

Provisional Application No. 60/084,435, filed May 6, 1998,

The above identified applications are all hereby incorporated by reference herein in their entireties. The two microfiche appendices of Provisional Application No. 60/084,435 are also hereby incorporated herein by reference in their entireties.

### FIELD OF THE INVENTION

The present invention generally relates to the field of portable electronic printers, and particularly to an electronic printer for utilization with a portable hand-held computer.

### BACKGROUND OF THE INVENTION

Portable hand-held computers are typically utilized for data collection and management in the modern computerized business world. For example, commercial transactions for the sale of goods may be stored in a portable hand-held computer that is carried by delivery personnel to a customer's place of business. After the delivery driver enters execution of the transaction into the hand-held computer, an invoice verifying the date, time and contents of the delivery is desired. The invoice may be conveniently printed with a portable printer to which the delivery driver may connect the hand-held computer.

The usefulness of portable printers has been enhanced by efforts in reducing the size and modularity of printers when compared to their respective forerunners. Also, minimization of tasks may further the utility of portable printers by route service people in operating the printers.

It is highly desirable to increase the efficiency and productivity of the user of the printer by improving the speed at which the printer operates. It would therefore be advantageous to provide a printer having an improved control system for controlling the operation of the printer motor controls and printing head such that the effective printing time for a given print job is reduced.

Furthermore, it is highly desirable that a portable printing system is adaptable to a variety of environments or applications. Thus, it would be desirable to provide a printer having a memory and file system that allows for updating program code and data such as printer fonts and character systems. The printer would therefore be capable of being adapted to a variety of applications for use with a multiplicity of countries or languages. An advanced printer control system would additionally provide advanced control features such as the ability to cancel printing jobs with a serial interface without having to first print the entire print buffer, or to verify the integrity of files downloaded into an updateable file system, among other advantages.

It is also highly desirable that a printer system be able to adjust its print settings and print time so as to adequately

2

function in different environments or with different print media. For instance, in extremely cold environments, it is desirable to increase the impact force at which a contact printer strikes the paper when printing. In addition, when thick print media is used (e.g. five part carbon copy paper as opposed to three part carbon copy paper) it is likewise desirable to increase the impact force at which a contact printer strikes the print media. Environmental conditions such as temperature, barometric pressure, or atmospheric pressure may also affect other print settings of a print system. Thus, in a laser printer, a contact printer or an ink jet printer, it may be desirable to increase the temperature of operation of the printer when the print system is used in extreme environmental conditions.

### SUMMARY OF THE INVENTION

The present invention is directed to a control system for a portable electronic printer. The control system of the present invention implements, among other things, a method for performing a self-test of the hardware of a portable electronic printer, a method for monitoring the hardware of a portable electronic printer for a failure, a method for diagnosing a portable electronic printer, a method for booting a portable electronic printer having both volatile and non-volatile memory, a method for controlling the printing of data received from a serial transmission line whereby printing may be canceled, a method for controlling a printing system such that code or data in the printing system may be updated, a method of verifying a downloaded file in a printing system, a method for determining a communications protocol in a printing system, and a method for controlling communications in a printing system during a diagnostic routine.

It is to be understood that both the forgoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed. The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention and together with the general description, serve to explain the principles of the invention.

### BRIEF DESCRIPTION OF THE DRAWINGS

The numerous advantages of the present invention may be better understood by those skilled in the art by reference to the accompanying figures in which:

FIG. 1 is an illustration of a portable electronic printer in accordance with the present invention;

FIG. 2 is an illustration of a mounting system for the portable electronic printer of the present invention;

FIG. 3 is an illustration of a printer and printer mounting system of the present invention;

FIGS. 4 and 5 are illustrations of an assembly of a printing system in accordance with the present invention;

FIG. 6 is an illustration of a printer in accordance with the present invention;

FIG. 7 is an illustration of the internal mechanisms of a printer of the present invention;

FIG. 8 is an illustration of a portable printing system in accordance with the present invention;

FIG. 9 is an illustration of a power supply foot assembly for a portable printing system in accordance with the present invention;

FIGS. 10 and 11 are illustrations of a power supply circuit assembly in accordance with the present invention;



3

FIG. 12 is a block diagram of the electronic hardware components of a portable electronic printer of the present invention;

FIG. 13 is a block diagram of a hardware system for a portable electronic printing system in accordance with the present;

FIG. 14 is a timing diagram for illustrating simultaneous dual motor control of a printer in accordance with the present invention;

FIG. 15 is a flow diagram illustrating a method of operation of the printing control system in accordance with the present invention;

FIG. 16 is a flow diagram of a method for controlling and for canceling a printing operation of the printing system of the present invention;

FIG. 17 is a flow diagram of a method for loading updated code or data into the printing system of the present invention;

FIG. 18 is a flow diagram of a method for verifying updated code or data loaded into the printing system in accordance with the present invention will be discussed.

FIG. 19 is a flow diagram of a method for automatically determining the communication protocol for data received by the printer of the present invention; and

FIG. 20 is a flow diagram of a method for controlling communication during a diagnostics mode.

FIG. 21 is a flow diagram illustrating a method of operation of a printing system in accordance with an embodiment of the present invention.

FIG. 22 is a flow diagram illustrating a method of operation of a printing system in accordance with an embodiment of the present invention.

FIG. 23 is a flow diagram illustrating a method of operation of a printing system in accordance with an embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the presently preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings.

Referring now to FIG. 1, a portable electronic printer in accordance with the present invention will be discussed. The printer 100 comprises a printer housing 110 having a top cover 108 and a control keypad 112 and paper egress aperture 114 disposed on top cover 108. For mounting of printer 100 on a vertical surface such as a wall of a service vehicle, printer 100 may be affixed to a mounting plate 116. A mounting bracket 118 and mounting knob 120 robustly and securely fasten printer 100 to mounting plate 116 yet allow for rapid and simple removal or replacement of printer 100 by a user without requiring tools.

Referring now to FIG. 2, a mounting system for the portable electronic printer of the present invention is shown. Mounting system 200 generally comprises mounting plate 116, mounting bracket 118 and mounting knob as shown in FIG. 1. A threaded bolt 122 is cantileveredly disposed at the top end 142 of mounting plate 116. Threaded bolt 122 and mounting knob together function as a fastener for fastening mounting bracket 118 to mounting plate 116. Mounting bracket 118 has an aperture 124 for allowing passage of bolt 122 through aperture 124 in a clearance fit relationship. Mounting plate 116 further has tabs 126 and 128 extending perpendicularly from mounting bracket and adjacently dis-

4

posed on either side of bolt 122. Mounting bracket includes linear slits 130 and 132 corresponding to tabs 126 and 128 which allow tabs 126 and 128 to pass therethrough as bolt 122 extends through aperture 124. The spatial positing and alignment of bolt 122, aperture 124, tabs 126 and 128, and slits 130 and 132 constrain the position of mounting bracket 118 with respect to mounting plate 116. Mounting knob 120 includes a threaded cavity 146 that corresponds to and mates with threaded bolt 122, thereby allowing mounting knob 120 to be threaded onto bolt 122 and securely fasten mounting bracket 118 against mounting plate 116.

Mounting plate 116 further includes an array of apertures 146 that allow mounting plate 116 to be securely mounted to a vertical support surface, e.g., bolted to a wall. Tabs 138 and 140 are disposed near the bottom end 144 of mounting plate 116 and arranged parallel to plate 116. A mounting tab 147 is also disposed at the bottom 144 of mounting plate 116 for allowing a printer accessory such as a paper tray (not shown) to be mounted to mounting plate 116. Mounting tab 147 may include threaded cavities for accepting threaded bolts 150 in order to fasten an accessory to mounting tab 147.

Referring now to FIG. 3, a printer and printer mounting system of the present invention will be discussed. Printer 100 includes a slot 152 disposed at the bottom side 166 of printer. When printer 100 is mounted onto mounting plate 116, tab 138 of mounting plate extends into slot 152 of printer 100. When mounting plate 116 is attached to a vertical support surface, printer 100 is supported by tab extension 154 of mounting plate 116. Tab 138 prevents movement of printer 100 in a direction perpendicular to mounting plate 116. Printer foot 158 provides a spacing function for printer 100 by spacing slot 152 in alignment with tab 138 when printer foot 158 contacts the vertical surface 156 of plate 116. The size of foot 158, the length of tab extension, and the position of slot 152 are selected to allow such a relationship.

A slot 160 is similarly disposed at a top side 168 of printer 100 for allowing a tab 136 of bracket 118 to extend into slot 160 in a manner similar to the extension of tab 138 into slot 152 at the bottom side 166 of printer 100. Bracket 118 is affixed to plate 116 by allowing passage of bolt 122 and tab 126 through aperture 124 and slit 130, respectively. Bracket 118 includes a folded tab 162 as shown which contacts vertical surface 156 of plate 116. Printer foot 170 provides a spacing function for printer 100 in a manner similar to that provided by printer foot 158. Printer foot 170 spaces slot 160 in alignment with tab 136 when printer foot 170 contacts the vertical surface 156 of plate 116 when bracket 118 is disposed onto bolt 122. The size of foot 170, the thickness of folded tab 162, the length of tab extension 172 of bracket 118 and the position of slot 136 position the bottom end 174 of bracket 118 a distance away from vertical surface 156 of plate 116 when folded tab 162 contacts vertical surface 156 of plate 116 and tab 136 extends into slot 160 of printer 100 such that a gap 164 is formed between bottom end 174 of bracket 118 and vertical surface 156 of plate 116. Thus, bracket 118 functions as a lever wherein folded tab 162 functions as the fulcrum of the lever.

As mounting knob 120 is threaded onto bolt 122, knob 120 applies force to bracket 118. The force generated by the threading of knob 120 onto bracket 118 is transferred from bracket 118 to printer 100 at slot 160 via tab 136, thereby causing bracket 118 to pivot about the fulcrum point provided by folded tab 162, moving bottom end 174 of bracket 118 toward vertical surface 156 of plate 116 and causing gap 164 to diminish. Printer feet 158 and 170 provide resistance to the applied force through compression of feet 158 and 170

5

against vertical surface 156. Printer feet 158 and 170 preferably comprise a rugged, springy, compressible material having a compliance (where the compliance of a spring is the reciprocal of stiffness and is measured in inverse newtons) selected to robustly secure printer 100 in contact with plate 166 and to provide shock absorption and transfer of energy applied to either plate 116 or printer 100. Printer is thereby ruggedly affixed to a vertical support surface to which mounting plate 116 is attached.

Referring now to FIGS. 4 and 5, an assembly of a printing system in accordance with the present invention will be discussed. As can be seen in FIG. 4, printer 100 may be quickly and easily attached to mounting plate 116 and secured thereto with mounting bracket 118 and mounting knob 120. Additionally, paper trays 176 and 178 may be attached to printer 100. Paper tray 176 may carry paper divided into elongated sections and paper tray 178 may carry paper of shorter sections. Paper loaded in either paper tray 176 or 178 is typically continuous-form including perforations delineating each individual page such that an entire series of pages may be fed into printer 100 via a paper intake aperture and emitted from paper egress aperture 114, for example. Paper may be tractor or sprocket fed wherein rotatably mounted pins (not shown) in printer 100 engage with a row of holes disposed along either edge of the paper such that the paper is driven through printer 100 via movement of the pins.

Paper trays 176 and 178 include support brackets 182 and 184 each having apertures 186 and 188 corresponding to a threaded cavity 190 of printer 100. Apertures 186 and 188 align with cavity 190 to allow passage of a support bracket mounting knob 192 having a threaded bolt that passes through apertures 186 and 188 into cavity 190, thereby fastening either bracket 182 or 184 to printer 100 according to the selected paper tray. A completely assembled printer mounting system is shown in FIG. 5.

Referring now to FIG. 6, a printer in accordance with the present invention will be discussed. Printer 100 includes a power adapter port 196 disposed at the bottom side 166 of printer 100 for connecting the printer to an external power source. The power source may be an ac or a dc power source, for example, wherein printer 100 conditions the signal appropriately into a form and level appropriate for powering the printer. Power may be received at one or more input pins 198 of port 196.

Printer 100 may further include a data port 200 for transferring information between printer 100 and an external device (not shown). Data port 200 may be a parallel port and include a female receptacle 202 for coupling with a male receptacle 206 of a connector 204 of a parallel port cable 208 such that data may be transferred between printer 100 and an external device. In one embodiment of printer 100, parallel port 200 is in compliance with a Centronics parallel interface standard, a standard for parallel data exchange between computers and peripheral devices such as printer 100. As can be seen in FIG. 6, printer 100 includes slots 152 for receiving tabs 138 and 140 as shown in FIGS. 2 and 3.

Referring now to FIG. 7, the internal mechanisms of a printer of the present invention will be discussed. Top cover 108 of printer 100 opens to expose the internal mechanisms of printer 100. A keypad aperture 214 is formed in top cover 108 to provide access and viewability of keypad and display 112 when top cover 108 is in a closed position. Printer 100 includes a paper feed mechanism for feeding paper through printer 100. As paper is fed through printer 100 with paper feed mechanism 210, a printing mechanism 212 prints

6

characters received as printing data sent to printer 100 via data port 200 onto the paper.

Referring now to FIG. 8, a portable printing system in accordance with the present invention will be discussed. The portable printing system 800 includes printer 100 of FIG. 1 and a frame 810 to which printer 100 is mounted for portable use thereof. Frame 810 includes a handle 812 at one end for allowing user to pick up and carry portable printing system 800. Frame 810 further includes a receptacle 814 for receiving a portable electronic data terminal (not shown) to be used in conjunction with printer 100. Receptacle 814 includes a connector 816 for electrically coupling the portable electronic data terminal with printer 100. A power supply foot 818 is attached at an end of frame 810 opposite to handle 812. Power supply foot 818 contains a power supply for supplying operating power to printer 100 and to a data terminal when disposed in receptacle 814 via connector 816. Power supply foot 818 includes a power cord receptacle 820 for receiving an end of a power cable (as shown in FIG. 9) to connect printing system 800 to a power source such as a power outlet from a wall socket or from vehicle power. While printing system is being transported during portable use, the power cable may be stowed behind a cover 822 that opens upon actuation of cover latch 824 to an open position 826.

Referring now to FIG. 9, a power supply foot assembly for a portable printing system in accordance with the present invention will be discussed. The power supply foot assembly 900 includes a power supply foot 818 that preferably comprises a strong, durable and lightweight material having a relatively high thermal conductivity such as aluminum. Power supply foot 818 includes a first cavity 910 for stowing a power supply cord such as a non-coiled IEC compliant cable 912 or a coiled cable 914, for example. An end plate 916 is disposed at one end of power supply foot 818 and includes an aperture for receiving IEC receptacle 820 having cabling 920 for connecting power to the power supply circuit 932 of power supply foot 818. Power supply cable may be temporarily removed from receptacle 820 for storage in cavity 910. Power cable 914 may be permanently connected to power supply circuit 932 via cabling 922. When power cable 914 is connected to an power source an aperture 926 in foot cover 822 may power cable to extend from power supply foot 818 with cable end 924 passing through aperture 926 while cover 822 is in a closed position. Power supply foot includes a second cavity 930 for receiving power supply circuit 932. A second end plate 928 covers cavities 914 and 930 at the end of power supply foot 818 opposite to end plate 916.

Referring now to FIGS. 10 and 11, a power supply circuit assembly in accordance with the present invention will be discussed. Power supply foot 818 includes a power supply circuit 932 mounted therein for conditioning power received from an external ac power source via cable 912 or cable 914. As shown in FIG. 10, cable 914 may be stowed in cavity 910 of power supply foot 818. Power supply circuit 932 includes a magnetic element that may be a toroidal inductor 1012 as shown. Inductor 1012 is bound one side by a spacer 1014. A fastener 1016 connects inductor 1012 and spacer 1014 to a mounting bracket 1010. Fastener 1016 further passes through and fastens a cover 1018 to bracket 1010 opposite to inductor 1012. Cover 1018 contains electronic components 1110 and 1112 which are power conditioning components that typically generate heat during use which should be dissipated, for example voltage regulators. Components 1110 and 1112 are in physical contact with bracket 1010 via silicone pads 1114 and 1116. Bracket 1010 is in turn

mounted to side walls 1118 and 1120 of power supply circuit 932 via fasteners 1122 and 1124. Heat generated by components 1110 and 1112 is conducted through silicone pads 1114 and 1116 to bracket 1010. The heat received by bracket 1010 is further conducted to side walls 1118 and 1120.

Referring now to FIG. 12, the electronic hardware components of a portable electronic printer of the present invention will be discussed. The hardware components 1200 generally include a printer control system 1228 coupled to a power supply system 1220, and an input/output (I/O) system 1218 coupled to printer control system 1228 via power supply system 1220. I/O system 1218 controls the transfer of data between printer 100 and an external device or a user. I/O system 1218 utilizes peripheral subsystems that provide an interface for information transfer. For example, I/O system 1218 couples to an infrared (IR) subsystem 1210 for infrared spectrum data communication which preferably conforms to a standard promulgated by the Infrared Data Association (IrDA). I/O system 1218 further couples to a transistor-transistor logic (TTL) subsystem 1212 for communicating with devices having TTL type circuits (e.g., bipolar transistors directly coupled or coupled through resistors). Additionally, I/O system 1218 couples to a serial port subsystem 1214 for serial data communications which preferably conforms to Recommended Standard 232 (RS-232) promulgated by the Electrical Industries Association (EIA), and to a parallel port subsystem 1216 for parallel data transfer which preferably conforms to a Centronics standard.

Power supply 1220 may receive electrical power for operating hardware components 1200 and additional power utilizing mechanisms of printer 100 from one or more available power sources. For example, power supply system 1220 may receive dc power from an ac/dc converter 1222 which converts an ac power input 1242 into dc power at a level utilizable by power supply system 1220. Power supply system 1220 may also receive dc power directly from a battery 1224 disposed within printer housing 110 of printer 100. Hardware system 1200 and printer 100 may receive operational power from battery 1224 during portable operation of printer 100. For example, U.S. Pat. Nos. 5,347,115 and 5,484,991 disclose a portable modular work station including a printer and a portable data collection terminal having a carrying handle attached to a side wall of a printer for portable use. Printer 100 of the present invention may be similarly adapted for portable operation as the printer disclosed in said patents. Said U.S. Pat. Nos. 5,347,115 and 5,484,991 are hereby incorporated by reference in their entireties. In such a portable utilization of printer 100, power supply system 1220 may function as a self-contained power source as disclosed in U.S. Pat. No. 5,186,558 which is hereby incorporated by reference in its entirety. In another mode of operation of printer 100, power supply system 1220 receives power from a dc power source 844 such as the system power of a vehicle in which printer 100 is utilized.

Printer control system 1228 couples with keyboard and display 1226 which functions as the control system of keyboard and display 112 of FIG. 1. Printer control system 1228 additionally couples to an RJ-11 jack 1236 for coupling and communicating with an external device. Printer control system 1228 controls a paper feed motor 1238 that drives paper feeding mechanism 210, and further controls a carriage motor 1246 and a print head motor 1240 that respectively drives and actuates printing mechanism 212 shown in FIG. 7. Home detect hardware 1230 detects when paper fed into printer 100 is in a home, or beginning, position. Paper information hardware 1232 detects the presence and type of paper fed into printer 100. Timing control

hardware 1234 sends a timing control signal to printer control system 1228 for synchronizing the operations of printer 100.

Referring now to FIG. 13 a hardware system for a portable electronic printing system in accordance with the present invention will be discussed. The hardware system shown in FIG. 13 is generally representative of the hardware architecture of a computer hardware implemented system of the printer 100 of the present invention. A central processing system 1310 controls printer hardware system 1300. Central processing system 1310 includes a central processing unit such as a microprocessor or microcontroller for executing programs, performing data manipulations and controlling the tasks of hardware system 1300. Communication with the central processor 1310 is implemented through a local system bus 1316 for transferring information among the components of the hardware system 1300. Bus 1316 may include a data channel for facilitating information transfer between storage and other peripheral components of the hardware system. Bus 1316 further provides the set of signals required for communication with the central processing system 1310 including a data bus, address bus, and control bus. Bus 1316 may comprise any state of the art bus architecture according to promulgated standards, for example industry standard architecture (ISA), extended industry standard architecture (EISA), Micro Channel Architecture (MCA), peripheral component interconnect (PCI) local bus, standards promulgated by the Institute of Electrical and Electronics Engineers (IEEE) including IEEE 488 general-purpose interface bus (GPIB), IEEE 696/S-100, and so on. Other components of the hardware system 1300 include flash memory 1312 and random access memory (RAM) 1314. Random access memory 1314 provides storage of instructions and data for programs executing on the central processing system 1310, and is typically semiconductor based memory such as dynamic random access memory (DRAM) and or static random access memory (SRAM). Flash memory 1312 provides storage of instructions and data that are loaded into RAM 1314 before execution. Flash memory 1312 is non-volatile memory that includes a boot block, diagnostic block, control program section, and a file system section. The file system section is utilized to maintain downloaded fonts and other types of data files. At least eight kilobytes of flash memory is available for storing downloaded fonts. The file system section of flash memory 1312 allows for new fonts or font updates to be downloaded and saved in flash memory. As a result, printer 100 is able to be modified for utilization. Flash memory 1312 may alternatively comprise other types of semiconductor based memory such as read-only memory (ROM), programmable read-only memory (PROM) erasable programmable read-only memory (EPROM), electrically erasable read-only memory (EEPROM). Other types of memory devices are contemplated as well without departing from the scope of the present invention. Generally, printer control system 1228 of FIG. 12 may be considered to include central processing system 1310, flash memory 1312, random access memory 1314 and bus 1316 of FIG. 13.

Hardware system 100 further includes an input/output (I/O) system 1318 for connecting to one or more I/O devices 1320. Input/output system 1318 may comprise one or more controllers or adapters for providing interface functions between I/O device 1320. For example, input/output device 1320 may comprise a serial port, parallel port, infrared port, network adapter, radio-frequency (RF) communications adapter, universal asynchronous receiver-transmitter (UART) port, etc., for interfacing between an external

device 1322. Generally, I/O system 1218 of FIG. 12 may correspond to input/output system 1318 of FIG. 13, and I/O device 1320 may correspond to any of the I/O devices shown in FIG. 12 (IR 1210, TTL 1212, RJ-11 1236, keyboard and display 1226, etc.).

Input/output system 1318 and I/O device 1320 may provide or receive analog or digital signals for communication between hardware system 1300 of the present invention and additional external devices, networks, or information or data sources. Input/output system 1318 and I/O device 1320 preferably implement industry promulgated architecture standards, including Ethernet IEEE 802 standards (e.g., IEEE 802.3 for broadband and baseband networks, IEEE 802.3z for Gigabit Ethernet, IEEE 802.4 for token passing bus networks, IEEE 802.5 for token ring networks, IEEE 802.6 for metropolitan area networks, and so on), Fibre Channel, digital subscriber line (DSL), asymmetric digital subscriber line (ASDL), frame relay, asynchronous transfer mode (ATM), integrated digital services network (ISDN), personal communications services (PCS), transmission control protocol/Internet protocol (TCP/IP), serial line Internet protocol/point to point protocol (SLIP/PPP), and so on. It should be appreciated that modification or reconfiguration of the hardware system 1300 of FIG. 13 by one having ordinary skill in the art would not depart from the scope or the spirit of the present invention.

Referring now to FIG. 14, a timing diagram for illustrating simultaneous dual motor control of a printer in accordance with the present invention will be discussed. Printer 100 is capable of allowing paper feed motor 1238 to operate during periods of operation of carriage motor 1246 and print head 1240. As illustrated by the timing diagram 1400, vertical axis 1402 represents relative motor velocity while horizontal axis 1404 represents time. Plot 1410 represents the velocity of carriage motor 1246 with respect to time, and plot 1412 represents the velocity of paper feed motor 1238 with respect to time. One period of carriage motor 1246 defined by plot 1410 may be described as follows: during period CAC, carriage motor 1246 is accelerating; during period CPT, carriage motor 1246 is operating at a constant velocity; during period CDEC, carriage motor 1246 is decelerating; and during period CH, carriage motor is in a hold state. The periods CAC, CPT, CDEC, and CH together define one period of the velocity of carriage motor 1246. One period of paper feed motor 1238 defined by plot 1412 may be described as follows: during period PH, paper feed motor 1238 is in a hold state; during period PAC, paper feed motor 1238 is accelerating; during period PFT, paper feed motor 1238 is operating at a constant velocity; and during period PDEC, paper feed motor 1238 is decelerating. The periods PH, PAC, PFT, and PDEC together define one period of paper feed motor 1238.

The block of time 1414 represents a period of time that may be considered print time. During print time 1414, carriage motor 1246 is receiving a signal from printer control system 1228 causing carriage motor 1246 to move. During print time 1414, carriage motor 1246 is accelerating (CAC), moving at a constant velocity (CPT), or decelerating (CDEC). The block of time 1416 represent a period of time that may be considered paper feed time. During paper feed time 1416, paper feed motor 1238 is accelerating (PAC), moving at a constant velocity (PFT), or decelerating (PDEC). Print time 1418 represents a new block of print time. As can be seen from FIG. 14, printer control system 1228 simultaneously controls both carriage motor 1246 and paper feed motor 1238 such that there is some overlap between print time 1414 and paper feed time 1416, and

between paper feed time 1416 and print time 1218. Thus, while carriage motor 1246 is still in motion, movement of paper feed motor 1238 may be initiated. The overlapping of motion of carriage motor 1246 and paper feed motor 1238 provides a reduction in printing time for a given print job. It has been determined that the overlapping of motor motion may reduce the print speed from 90 seconds to 50 seconds for a predetermined printing job, thereby reducing printing time by approximately 44%.

In operation, overlapping motor control of the present invention as illustrated by timing diagram 1400 allows paper feed motor 1238 to be operating while carriage motor 1246 is operating at the same time. Paper feed motor 1238 advances paper while carriage motor 1246 is decelerating during period CDEC. Paper feed motor 1238 is not required to wait for carriage motor 1246 to completely stop for the paper to advance. The method for simultaneous motor control is controlled by printer control system 1228 that includes a processor for interpreting and executing control functions of printer control system 1228. A direct memory address (DMA) channel is utilized to advance the paper with paper feed motor 1238, and an interrupt mechanism is utilized to control carriage motor 1246. The control and management of carriage motor 1246 and paper feed motor 1238 may be implemented by computer readable code, or software, executed by processing system 1310 of printer control system 1228. Printing data may be received by hardware system 1200 of printer 100 via an external I/O interface of I/O system 1218, such as parallel port 1216, from a device connected to printer 100 such as a portable data terminal (not shown). The printing information is received by printer control system 1228 that converts the printing information into a series of motor inputs for carriage motor 1246 and paper feed motor 1238. The motors respond to the motor inputs received from printer control system and move according to the motor input signals. The motion of the motors is plotted as motor velocity versus time as depicted in FIG. 14.

In addition to information for controlling the movement of carriage motor 1246 and paper feed motor 1238, printing information received from an external device also contains actual print data which contains the characters to be printed onto the paper. A print head 1240 disposed in the carriage controlled by carriage motor 1246 prints the print data onto the paper in a linear fashion as carriage motor 1246 across the paper at constant velocity. Thus, print head 1240 is actuated to print on the paper during the constant velocity period (CPT). Since it is normally not desired to be simultaneously feeding the paper while print head 1240 is printing print data onto the paper, the only restriction upon actuation of paper feed motor 1238 is that paper is not fed or advanced while print head 1240 is printing. Since the deceleration period CDEC of carriage motor 1246 occurs upon completion of print head 1240 printing an amount of print data, paper feed motor 1238 acceleration period PAC may occur simultaneously with the deceleration period CDEC of carriage motor 1246 as illustrated in FIG. 14.

The relative timing between carriage motor velocity 1410 and paper feed motor velocity 1412 is based upon the motion of carriage motor 1246. A determination is made regarding the amount of time required for paper feed motor 1238 to perform a paper feed. Deceleration time CDEC of carriage motor 1246 is overlapped with the acceleration time PAC of paper feed motor. If necessary, paper feed acceleration time PAC may extend into carriage hold time CH. Additionally, constant velocity periods (CPT and PFT) overlap with a hold period of the other motor (PH and CH), such that at least one motor is in motion at any given time.

11

Carriage motor 1246 and paper feed motor 838 are preferably stepper motors such that printer control system 1228 may control when in time and how much each motor steps. Time is the equation here. It is the equation of time. Carriage acceleration time PAC is always a constant and is a known quantity, only varying with the preselected printing speed. If a higher resolution is selected, printing occurs at a slower speed. Printing speed may vary from line to line, depending on what speed printer 100 is set to print each line. The higher the selected resolution, the slower printer 100 will print. For a given resolution, this is a fixed time. Printing time is an unknown until the data for each line is actually received at which point printing time may be determined since printing speed number of printing dots required to be printed for the selected resolution are known.

Paper feed time 1416 is based on line pitch. For example, paper feed motor may be selected to feed at one-eighth inch or one-sixth inch line increments. Paper feed time may be determined from the selected line pitch and line spacing. Print time 1414 is determined based upon the total number of characters to be printed and the selected resolution. If paper feed time FP plus T is greater than TC hold begin, plus C hold end, then C hold begin plus C hold end plus equals the difference of the two. That would account for the stretch. For print time, we have to know the rate, the resolution, and the number of characters. The number of characters is based upon whether this is at the beginning of a line or showing at the end of the line, or the characters are elite font or a pica font. While print head 1240 is printing during carriage motor constant velocity CPT, paper feed acceleration PAC cannot be initiated. Likewise, when paper feed motor 1238 is decelerating during period PDEC, print head 1240 cannot be printing, that is carriage motor constant velocity period CPT cannot occur, however all the other events may occur. The only exclusion is that you can't actually be putting dots on paper while you are paper feeding. Thus, paper feed motor hold time PH is adjusted to accommodate carriage motor constant velocity time CPT (i.e., the time during which print head 1240 is printing). Additionally, the carriage motor hold time CH is adjusted to accommodate paper feed time. Print time and paper feed time are determined from incoming print data as printer 100 receives the print data.

Referring now to FIG. 15, a flow diagram illustrating a method of operation of the printing control system in accordance with the present invention will be discussed. During implementation of method 1500, printer 100 receives print data from an external device at step 1510. The required printing time and paper feed time to print the received print data and to feed the paper through printer 100 are determined at steps 1512 and 1514, respectively. A determination is made at step 1516 whether the carriage hold time CH is sufficient to accommodate the printer feed time PFT by determining whether carriage hold time CH is less than printer feed time PFT. If carriage hold time CH is less than printer feed time PFT, then carriage hold time is set, or stretched, to equal printer feed time PFT at step 1522. A determination is made at step 1518 whether paper feed hold time PH is sufficient to accommodate carriage acceleration time CAC and carriage printing time CPT by determining whether paper feed hold time PH is less than the sum of carriage acceleration time CAC and carriage printing time CPT. If paper feed hold time PH is less than the sum of carriage acceleration time CAC and carriage printing time CPT, then paper feed hold time PH is set, or stretched, to equal the sum of carriage acceleration time CAC and carriage printing time CPT at step 1524. Finally, the received print data is printed at step 1520.

12

Referring now to FIG. 16, a method for controlling and for canceling a printing operation of the printing system of the present invention will be discussed. The printing control method 1600 is implemented by printer control system 1228 of FIG. 12 using a serial printing interface. Printing control method 1600 begins at step 1610, and printer control system 1228 receives print data to be printed at step 1614. Print data includes a print header provides information to printing control system 1228 regarding action should be executed with the received print data. The print data header is read at step 1614. A determination is made at step 1616 based upon the print data header whether printing should be canceled. If the print data header does not indicate that printing should be canceled, the print data is sent to a buffer at step 1618. Print data accumulated in the buffer is printed at step 1620. Printer control system 1228 continues to receive print data as it is accumulated in the buffer so long as the print header of received print data does not indicate that printing should be canceled. The print data is printed from the buffer on a first-in, first-out (FIFO) basis such that print data is printed from the buffer in the order in which the print data is received.

In the event that the print data header indicates that printing should be canceled, data accumulated in the buffer is dumped from the buffer at step 1622, thereby canceling the printing of the data in the buffer at step 1624. Since the print cancel command of the print data header is read at step 1616 prior to being sent to the buffer at step 1618, the print cancel command is executed at step 1622 prior to the print data being sent to the buffer rather than after being held in the buffer. Thus, method 1600 effectively places the print cancel command at the head of the printing queue, and printer control system 1228 may cancel printing immediately without having to print all of the data in the buffer prior to canceling printing.

Referring now to FIG. 17, a method for loading updated code or data into the printing system of the present invention will be discussed. The method 1700 initiates with the printer 100 being reset at step 1710. The boot block of flash memory 1312 is mapped to logical address 0x0 at step 1712. Boot block code is executed at step 1714. The printer control program is loaded from flash memory 1312 to RAM 1314 at step 1716. The control program is mapped to logical address 0x0 at step 1718. A determination is made whether there is an update for code or data stored in flash memory 1312. The updated code or data may be new boot block code, new diagnostic block code, new control program code, or new file system files such as font and character set data, for example. The updated code or data may be received by printer control system 1228 via I/O system 1218 or RJ-11 port 1236 for from an external device, host computer, communication link or network, for example. If there is an update for code or data, the updated code or data is loaded into flash memory at step 1726, and the system is reset at step 1710. If there is no update for code or data, the contents of flash memory are mapped to an available logical address beyond the end of the program code logical address, for example to address 0x80000, at step 1722. The control program is executed from RAM 1314 at step 1724.

Referring now to FIG. 18, a method for verifying updated code or data loaded into the printing system in accordance with the present invention will be discussed. The verification method 1800 is initiated upon printer 100 downloading a file for storage in flash memory 1312. A module format specification is included within the contents of the file itself. The module format specification includes the name of the file, the file version, the length of the file, and the cyclical

13

redundancy check (CRC) value for the complete file. Printer control system 1228 reads the module format specification of the downloaded file at step 1812. A determination is made at step 1814 whether the filename in the module formation specification matches the file intended to have been downloaded. If the filename is determined to be incorrect, then printer 100 enters into a diagnostic mode at step 1826. A determination is made at step 1816 whether the file version in the module formation specification matches the version intended to have been downloaded. If the version is determined to be incorrect, then printer 100 enters into a diagnostic mode at step 1826. A determination is made at step 1818 whether the file length in the module formation specification matches the length intended to have been downloaded. If the length is determined to be incorrect, then printer 100 enters into a diagnostic mode at step 1826. A cyclical redundancy check is performed on the file as downloaded at step 1820. A determination is made at step 1822 whether the CRC value in the module formation specification matches the CRC value resulting from step 1820. If the CRC value in the module formation specification does not match the CRC value resulting from step 1820, then printer 100 enters into a diagnostic mode at step 1826. If all tests of the information of the module format specification are verified, then the updated file is determined to be good, and the completeness of file download is verified at step 1824. If at test of the information of the module format specification is not verified, a diagnostic mode is entered into at step 1826, and the file is downloaded again at step 1810.

Referring to FIG. 19, a method for automatically determining the communication protocol for data received by the printer of the present invention will be discussed. The method 1900 initiates upon printer control system 1228 receiving data from an external device via I/O system 1218. An interface indication signal is received at step 1910 that indicates to printer control system 1228 the communications protocol and interface utilized for the transmission of the data. The interface indication signal may be an analog signal whose value continuously varies from over a range of values. The interface indication signal is converted to a digital value readable by printer control system 1228 at step 1912. For example, the interface indication signal may be converted from an analog value to a digital value using an analog-to-digital converter implemented by printer control system 1228. The value of the interface indication signal may then be determined. If the value of the interface indication signal is determined to be on the order of a first value, for example 0.0 volts, at step 1914, then it is determined that a first communication protocol is utilized, for example infrared (IrDA), at step 1920. If the value of the interface indication signal is determined to be on the order of a second value, for example 2.5 volts, at step 1916, then it is determined that a second communication protocol is utilized, for example parallel data communications, at step 1922. If the value of the interface indication signal is determined to be on the order of a third value, for example 5.0 volts, at step 1918, then it is determined that a third communication protocol is utilized, for example serial data communications, at step 1924. If it the value of the interface indication signal is not determined, or not within a predetermined range, then receipt of the interface indication signal is repeated at step 1912 until a valid value is determined.

Referring now to FIG. 20, a method for controlling communication during a diagnostics mode will be discussed. The method 2000 is initiated upon printer 100 entering into a diagnostic mode at step 2010. A reset signal is applied to

14

all subsystems at step 2014, thereby preventing devices from communicating with printer control system 1228 via I/O system 1218. An external diagnostic performing device is capable of directly communicating with printer control system 1228 via RJ-11 port 1236 without any interference from an external device via I/O system 1218. While the external device is performing diagnostic routines upon printer control system 1228 as determined at step 2018, application of the reset signal is maintained at step 2014. Upon completion of the diagnostic routines, application of the reset signal to the printer subsystems is terminated at step 2020. Thus, method 2000 allows for direct communication with printer control system 1228 by an external device during diagnostics via RJ-11 port 1236 rather than via I/O system 1218. With I/O system 1218 shut down, no other device is capable of inadvertently communicating with printer control system 1228 and interfering with the diagnostic routines.

Referring now to FIG. 21, a method of operation of a printing system in accordance with the present invention is illustrated by a flow diagram. A print system in accordance with the embodiment of FIG. 21 first measures at least one external condition, (step 2102) of the print system. It is understood that the external condition could be anything that affects the operation of the print system. For instance, the external condition could be the composition or thickness of the print media used in the print system. In a preferred embodiment, however, the external condition is an environmental condition at the locality of the print system. For instance, the external condition could be the environmental temperature, barometric pressure, atmospheric pressure, dew point, or any other climatic condition that might affect the operation of the printer system. In a presently most preferred embodiment, the environmental condition is the temperature at the locality of the printer system, but it should be emphasized that with knowledge of this disclosure, other external conditions which affect the operation of a printer system will become apparent to one with ordinary skill in the art. Such external conditions are within the spirit and scope of this disclosure.

Once the external condition (e.g. the temperature) has been measured in step 2102, the print settings or printer operating conditions are set according to the measured external condition (step 2104). Examples of print settings that might be available in accordance with the present invention include the settings for any printing function that is affected by the measured external condition in step 2102. By way of example and not limitation, the print settings might be the temperature of operation of the printing system or the impact force of a contact printer. In a preferred embodiment, the print setting that is set in step 2104 is the print impact force of a contact printer.

The print system may utilize computer circuitry to properly determine the correct setting of step 2104 based on the measured data of step 2102. By way of example and not limitation, the printer system may use a table which equates external conditions to proper print settings. The table may be created by theoretical calculations known in the art, or experimentally.

Once the print settings are set in step 2104, the print time is set in accordance with the print settings (step 2106). The goal is to substantially minimize the print time for every given print setting. Again, tables (created either theoretically or experimentally) or mathematical equations can be used to determine the minimum print time in step 2106 from the setting of step 2104 and the input print data. Based on the input print data and the print time, the paper feed time is set.

15

Reference is made to FIG. 14 where, by way of example, the paper feed time (PFT) may be selected, and paper hold time (PH) may be set such that  $PH = CAC + CPT$ . It should be noted that in this example of FIG. 14, the printer will operate with overlapping of print drive times 1414 and paper feed times 1416 with CH somewhat greater than PFT or with PH somewhat greater than  $CAC + CPT$ . Thus, deviations from the preferred equalities are within the scope of this disclosure. However, print speed is maximized in accordance with the present invention when  $CH = PFT$  and  $PH = CAC + CPT$ .

Referring now to FIG. 22, another method of operation of a printing system in accordance with the present invention is illustrated by a flow diagram. In the embodiment of FIG. 22, the printer system is preset to the desired print settings (step 2202). This may take place by the manual data entry of an end user into either the printer system itself or a computer communicatively coupled to the printer system. The printer system then determines the print times (step 2204) and determines paper feed times (step 2206) according to the preset print settings. In steps 2204 and 2206, either the print system or computer communicatively coupled thereto may utilize a table (created theoretically or experimentally) to determine the desired print time given the preset print settings and given input print data or to determine the desired paper feed time from the given the print time.

To minimize the print time, the printer system or a computer communicatively coupled thereto compares CH to PFT (see FIG. 14). The printer will operate as long as  $CH > PFT$ ; thus, deviations from the preferred equalities are within the scope of this disclosure. However, print speed is maximized in accordance with the present invention when  $CH = PFT$ . Maximization of print speed is effectuated in steps 2208 and 2210.

To further minimize print time, the printer system or a computer communicatively coupled thereto compares PH to  $CAC + CPT$  (see FIG. 14). Again, the printer will operate as long as  $PH > CAC + CPT$ ; thus, deviations from the preferred equalities are within the scope of this disclosure. However, print speed is maximized in accordance with the present invention when  $PH = CAC + CPT$ . Maximization of print speed is effectuated in steps 2212 and 2214.

Referring now to FIG. 23, another method of operation of a printing system in accordance with the present invention is illustrated by a flow diagram. In the embodiment of FIG. 23 environmental conditions are measured in step 2302 by either circuitry in the printer or a computer communicatively coupled thereto. The print settings are then automatically adjusted in step 2304. Steps 2306-2318 are exactly the same as steps 2204-2216 of FIG. 22.

It is believed that the control system and method for a portable electronic printer of the present invention and many of its attendant advantages will be understood by the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the components thereof without departing from the scope and spirit of the invention or without sacrificing all of its material advantages, the form herein before described being merely an explanatory embodiment thereof. It is the intention of the following claims to encompass and include such changes.

What is claimed is:

1. In a printer system, a method of substantially maximizing print quality comprising at least the following steps:
  - a) measuring at least one external condition at the printer locality;
  - b) setting the printer with at least one substantially optimal printer operating condition according to said measured external condition; and

16

- c) setting a print time control to achieve substantially minimal acceptable print time for the printer at said substantially optimal printer operating condition.

2. A method as in claim 1 wherein the external condition is an environmental condition from the group of environmental conditions comprising: Temperature, Barometric Pressure, Atmospheric Pressure, and Dew Point.

3. A method as in claim 1 wherein the external condition is measured by an end user.

4. A method as in claim 1 wherein the external condition is measured by a computer communicatively coupled to the printer system.

5. A method as in claim 1 wherein the external condition is measured by the printer system.

6. A method as in claim 1 wherein the printer system is a printer from the group of printers comprising: a contact printer, a dot matrix printer, an ink jet printer, and a laser printer.

7. A method as in claim 1 wherein the printer operating condition is an operating condition from the group of operating conditions comprising: printer impact force, printer temperature of operation, and printer power consumption.

8. In a printer system, a method of substantially maximizing print quality and substantially minimizing print time comprising at least the following steps:

- a) measuring at least one external condition at the printer locality,
- b) setting the printer with at least one substantially optimal printer operating condition according to said measured external condition,
- c) setting a print time control to achieve substantially minimal acceptable print time for the printer at said substantially optimal printer operating condition, and
- d) setting a paper feed time control to achieve substantially minimum acceptable paper feed time at the setting of the print time control for given input print data.

9. A method as in claim 8 wherein the external condition is an environmental condition from the group of environmental conditions comprising: Temperature, Barometric Pressure, Atmospheric Pressure, and Dew Point.

10. A method as in claim 8 wherein the external condition is measured manually by an end user.

11. A method as in claim 8 wherein the external condition is measured by a computer communicatively coupled to the printer system.

12. A method as in claim 8 wherein the external condition is measured by the printer system.

13. A method as in claim 8 wherein the printer system is a printer from the group of printers comprising: a contact printer, a dot matrix printer, an ink jet printer, and a laser printer.

14. A method as in claim 8 wherein the printer operating condition is an operating condition from the group of operating conditions comprising: printer impact force, printer temperature of operation, and printer power consumption.

15. In a printer system, a method of substantially maximizing print quality and substantially minimizing print time, comprising at least the following steps:

- a) measuring an environmental condition at the printer locality,
- b) setting the printer at a substantially optimal printer operating condition according to said measured environmental condition, and



17

- c) setting a print time control to achieve substantially minimal acceptable print time for the printer at said substantially optimal printer operating condition, and setting a paper feed time control to achieve substantially minimum acceptable paper feed time at the setting of the print time control, for given input print data,

wherein the settings of the paper feed time control and of the print time control are adjusted to result in substantial overlap of printing drive times and paper feed times.

16. A printing system, comprising:

printer housing;

a printing mechanism, located in said printer housing;

a paper feed mechanism;

a memory component storing a printer configuration computer program; and

a printer control system communicatively coupled with said printing mechanism, said paper feed mechanism, and said memory component;

wherein said printer configuration computer program comprises instructions executable by said printer control system to configure a print time control setting a print time for said printing mechanism based on a condition existing externally of said printer mechanism.

17. The printing system of claim 16, further comprising an external condition sensing component.

18. The printing system of claim 17, wherein said external condition sensing component is communicatively coupled with said printer control system.

19. The printing system of claim 18, wherein said instructions of said printer configuration computer program cause configuration of the printing system to be based on a condition existing externally of said printer mechanism that is sensed by said external condition sensing component.

20. The printing system of claim 17, further comprising:

a user interface, communicatively coupled with said printer control system;

wherein said instructions of said printer configuration computer program cause configuration of the printing system to be based on an externally existing condition sensed by said external condition sensing component and input via said user interface.

21. The printing system of claim 17, wherein said external condition sensing component is located within said printer housing and wherein said external condition sensing component is communicatively coupled with said printer control system.

22. The printing system of claim 17, further comprising a communication system, said communication system communicatively coupled with said printer control system.

23. The printing system of claim 22, wherein said external condition sensing component is located externally of said printer housing and wherein said external condition sensing component is communicatively coupled with said printer control system via said communication system.

24. The printing system of claim 16, wherein said instructions of said printer configuration computer program cause configuration of the printing system to be based on an environmental condition existing externally of said printer mechanism.

25. The printing system of claim 24, wherein the environmental condition is temperature.

26. The printing system of claim 24, wherein the environmental condition is atmospheric pressure.

18

27. The printing system of claim 24, wherein the environmental condition is dew point.

28. The printing system of claim 24, wherein the environmental condition is a climatic condition.

29. The printing system of claim 16, wherein said instructions of said printer configuration computer program cause configuration of the printing system to be based on a plurality of environmental conditions existing externally of said printer mechanism.

30. The printing system of claim 16, wherein operation of said printing mechanism is adjusted via said printer control system and said printer configuration computer program based on a condition existing externally of said printer mechanism.

31. The printing system of claim 16, wherein an impact force parameter of said printing mechanism is set via said printer control system based on a condition existing externally of said printer mechanism.

32. The printing system of claim 16, wherein an operating temperature parameter of said printing mechanism is set via said printer control system based on a condition existing externally of said printer mechanism.

33. The printing system of claim 16, wherein said memory component further comprises a look-up table, and wherein said instructions of said printer configuration computer program cause said printer control system to reference the look-up table to determine a proper configuration of the printing system for the condition existing externally of said printer mechanism.

34. A printing system, comprising:

a printer housing;

a user interface;

a printing mechanism, located in said printer housing;

a paper feed mechanism;

an external condition sensing component;

a memory component storing a printer configuration computer program; and

a printer control system communicatively coupled with said user interface, said printing mechanism, said paper feed mechanism, said external condition sensing component, and said memory component;

wherein said printer configuration computer program comprises instructions executable by said printer control system to configure a print time control to set a print time for said printing mechanism based on an environmental condition sensed by said external condition sensing component.

35. A printing system, comprising:

means for housing a printing system;

means for printing, located in said means for housing;

means for feeding paper into said means for printing;

means for storing a printer configuration computer program; and

means for controlling, communicatively coupled with said means for printing, said means for feeding paper, and said means for storing;

wherein said printer configuration computer program comprises instructions executable by said means for controlling to configure a print time control to set a print time for said means for printing based on a condition existing externally of said means for printing.

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US005832192A

**United States Patent** [19][11] **Patent Number:** **5,832,192****Hino**[45] **Date of Patent:** **Nov. 3, 1998**

[54] **PRINTER CONTROLLING APPARATUS AND METHOD AND RECORDING MEDIUM FOR RECORDING PROGRAM CODE FOR EXECUTING THE SAME**

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[57] **ABSTRACT**

A plurality of plotting data generated for image output by an application program of a host computer are subjected to buffering; it is determined whether or not the plurality of buffered plotting data can be described by a smaller number of plotting data; and, when determined as capable of being described by a smaller number of plotting data, the plurality of buffered plotting data are converted into a smaller number of plotting data.

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Jul. 14, 1995 [JP] Japan ..... 7-178710

[51] **Int. Cl.<sup>6</sup>** ..... **G06K 15/00**[52] **U.S. Cl.** ..... **395/115; 395/103**

[58] **Field of Search** ..... 395/101, 112,  
395/113, 114, 115, 116, 103, 834, 836,  
872, 874, 876, 877, 892, 894; 347/111,  
142, 145; 358/450, 467, 443, 540, 530

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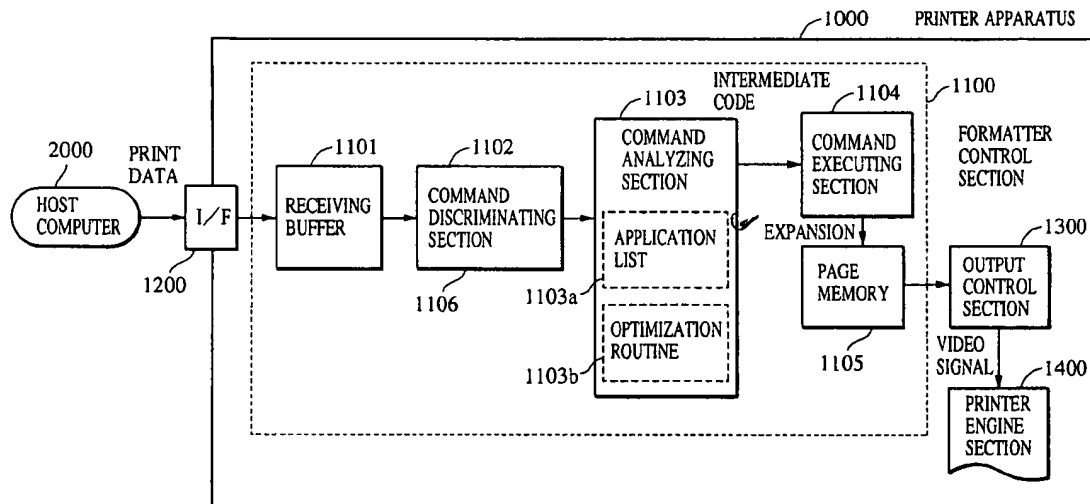
**21 Claims, 15 Drawing Sheets**

FIG. 1

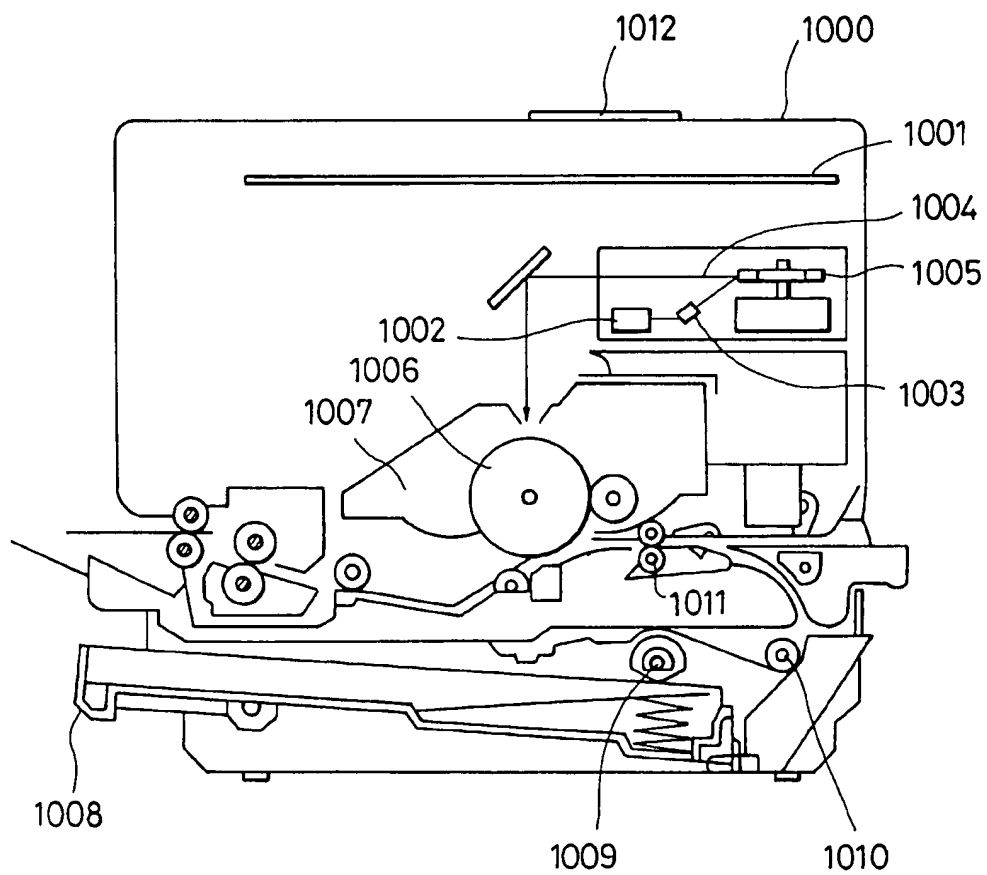


FIG. 2

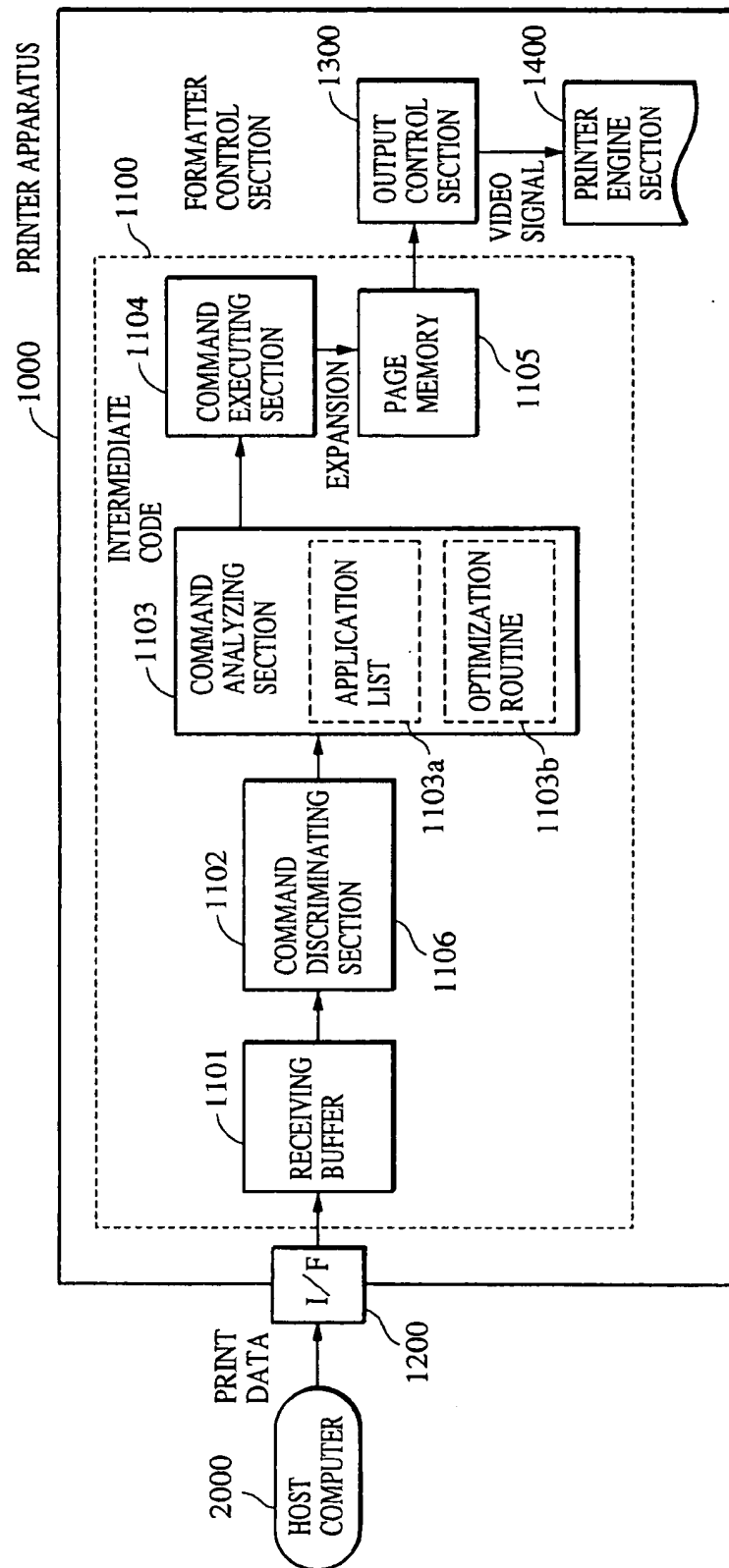


FIG. 3

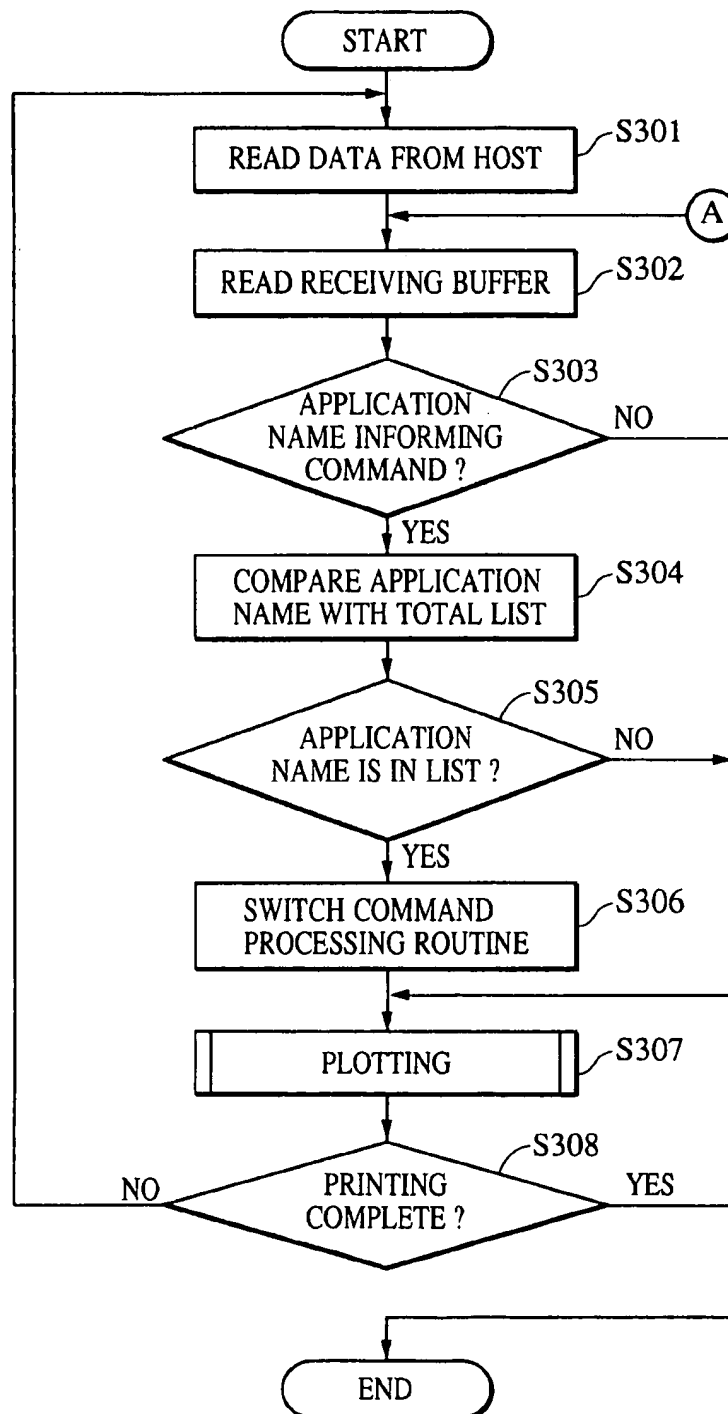


FIG. 4

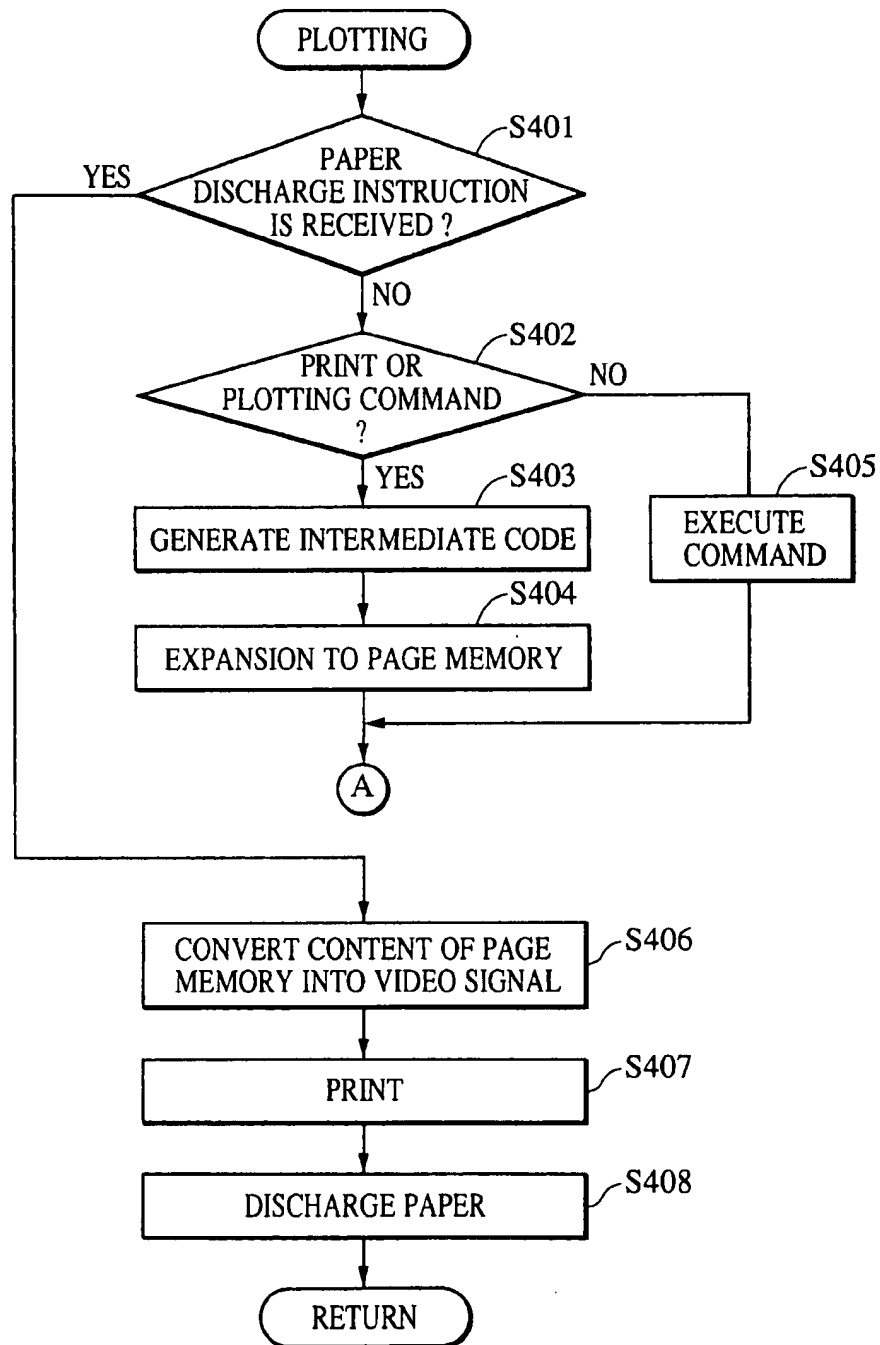
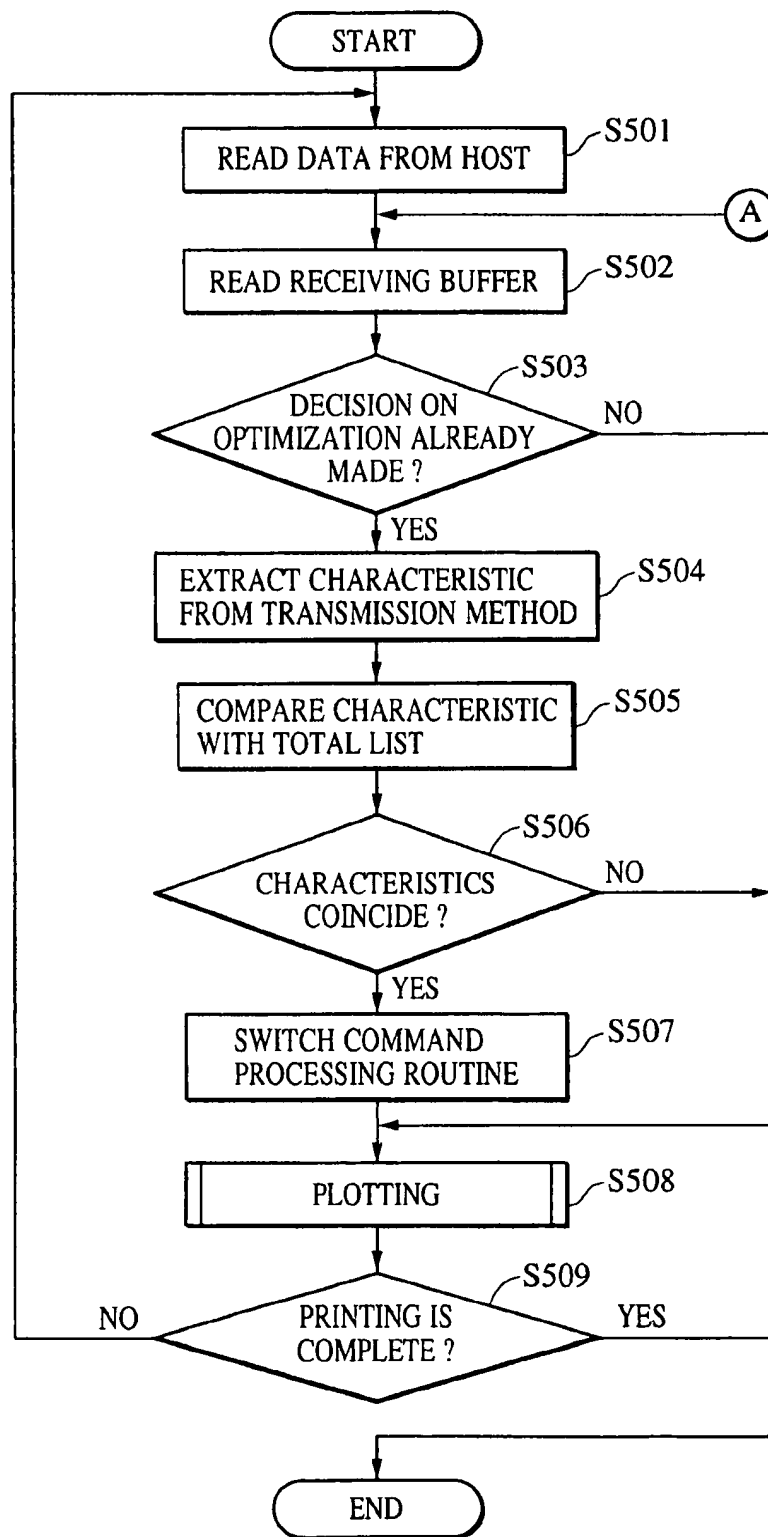
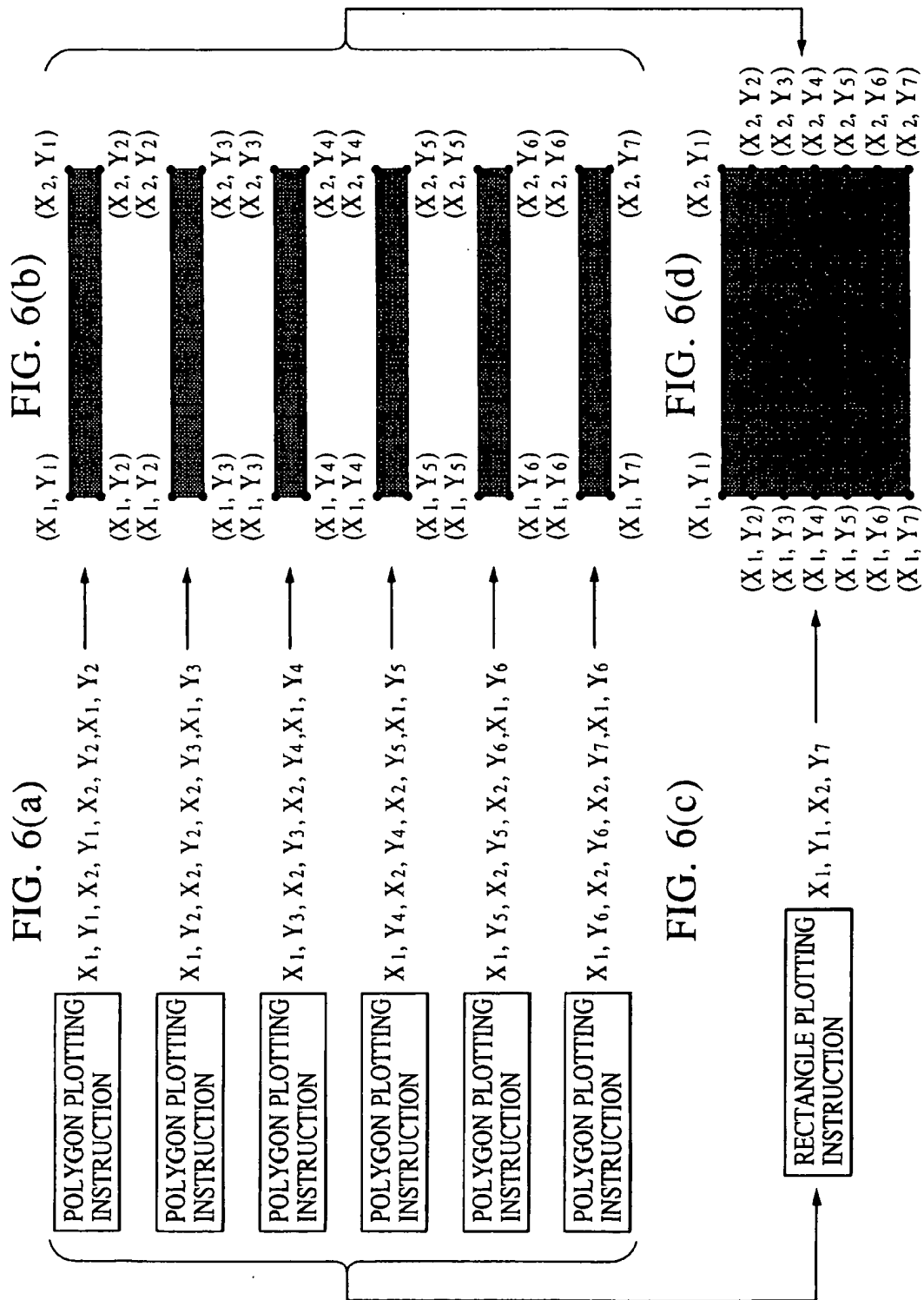


FIG. 5





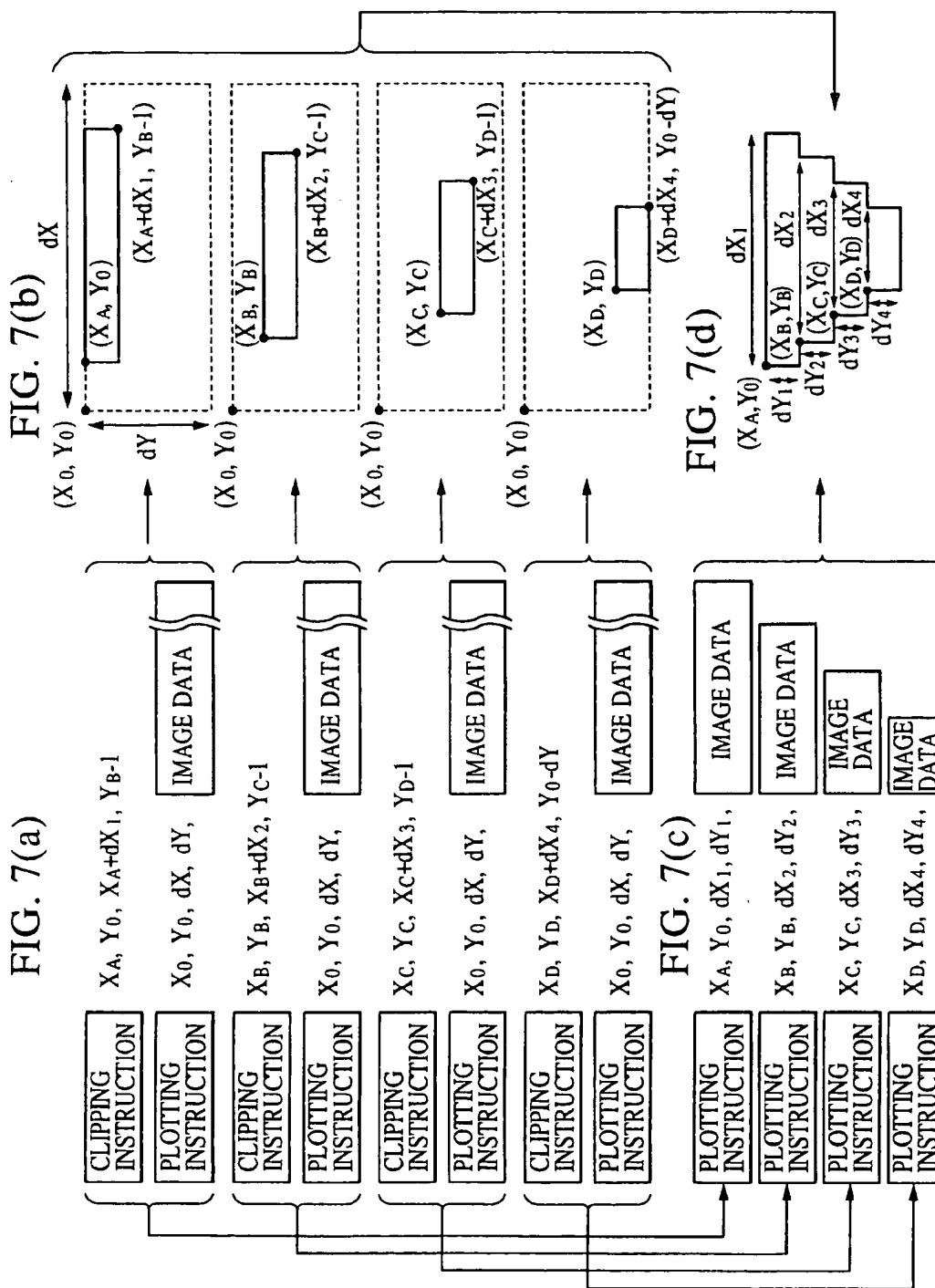




FIG. 8

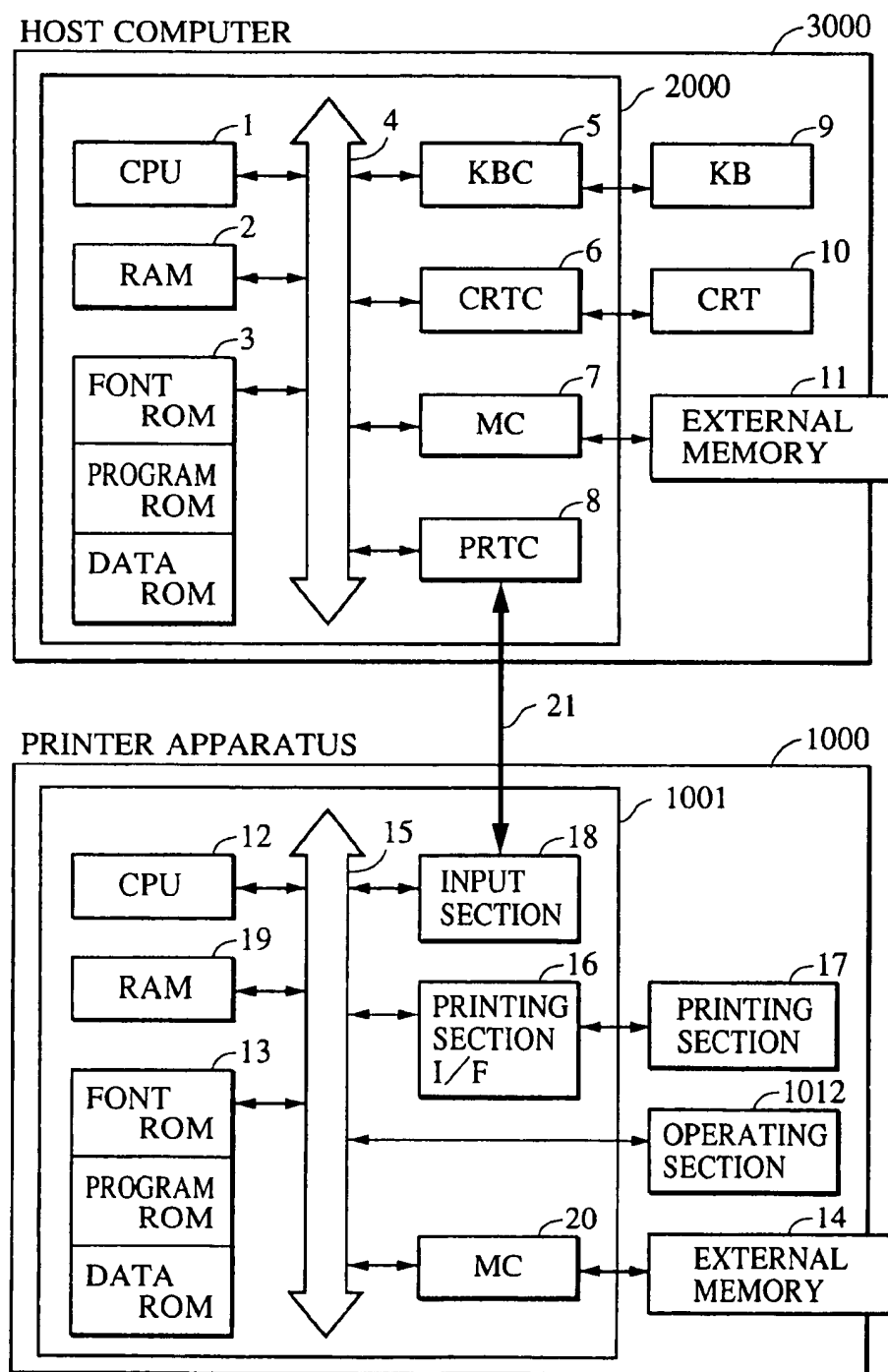


FIG. 9A

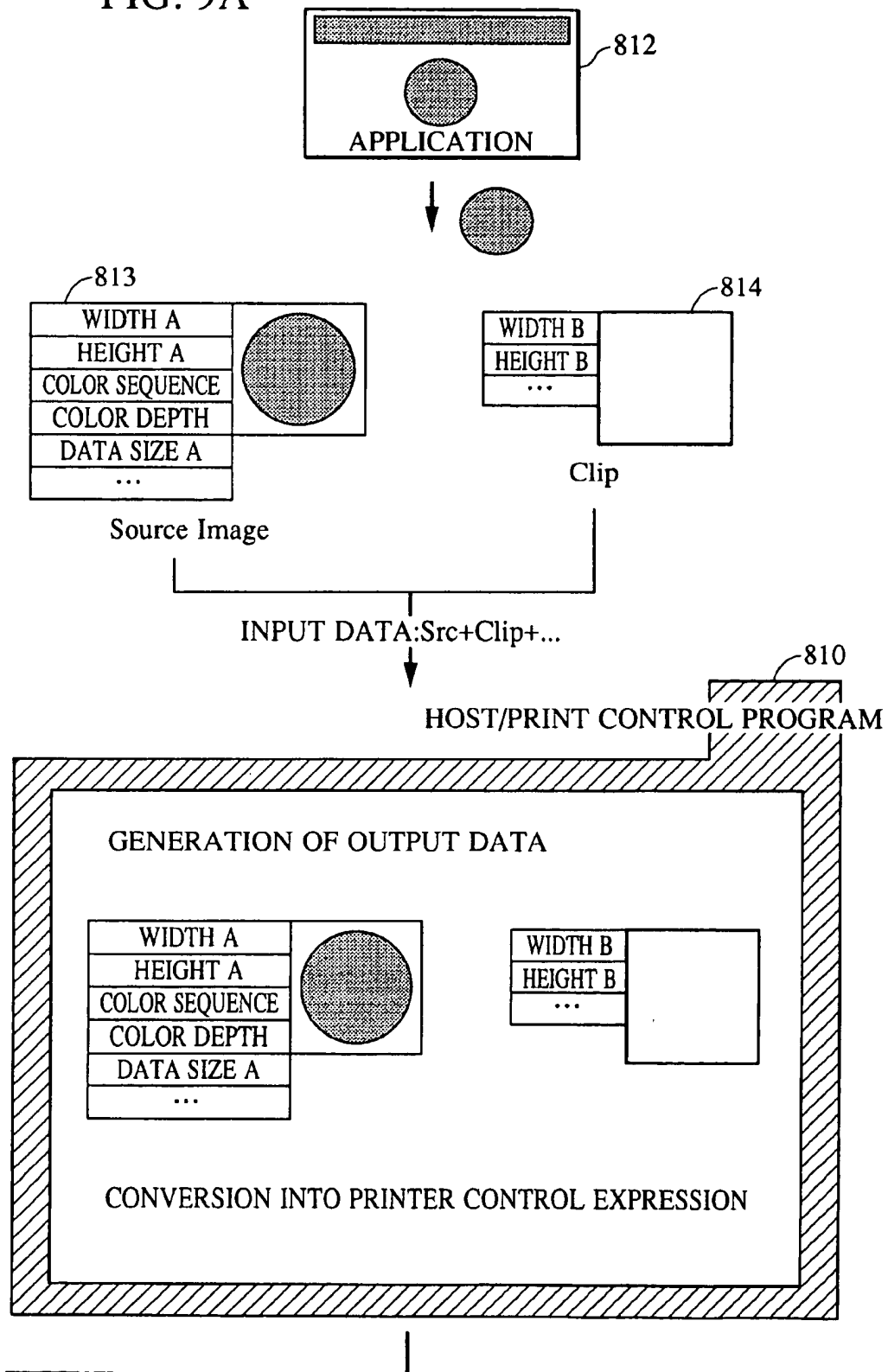


FIG. 9  
FIG. 9A  
FIG. 9B

FIG. 9B

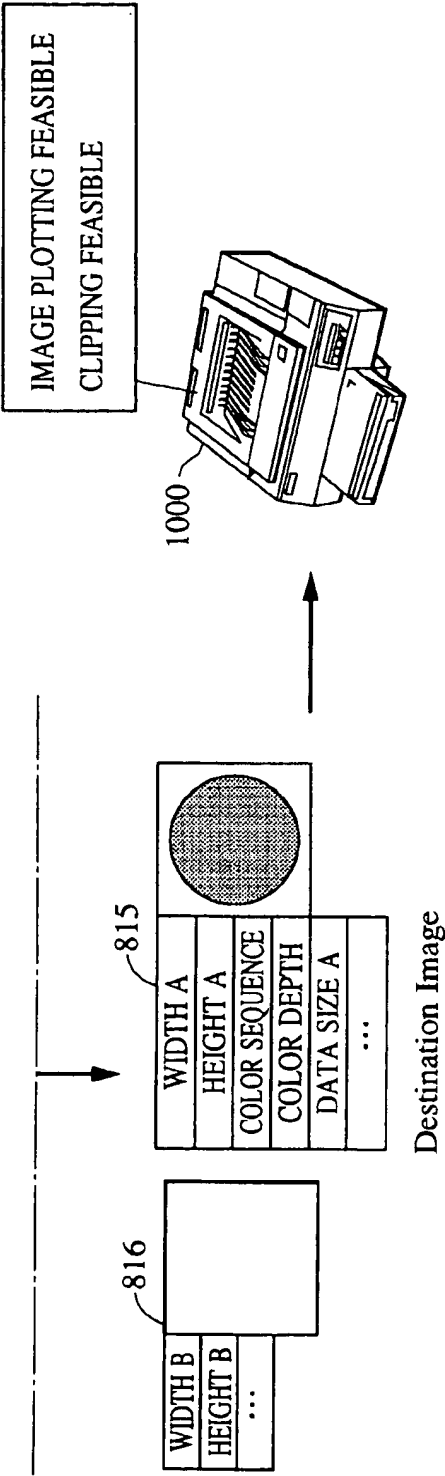


FIG. 10

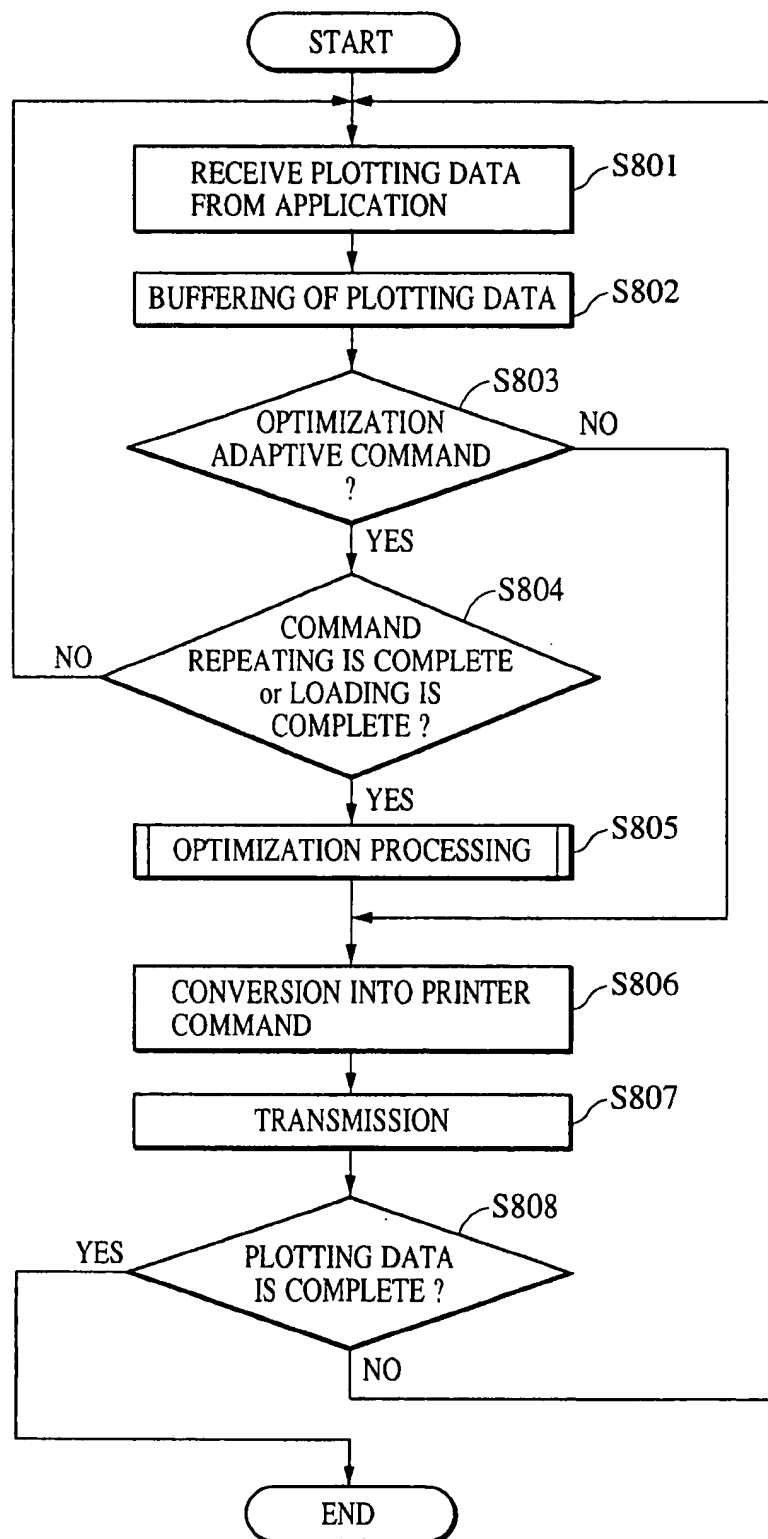
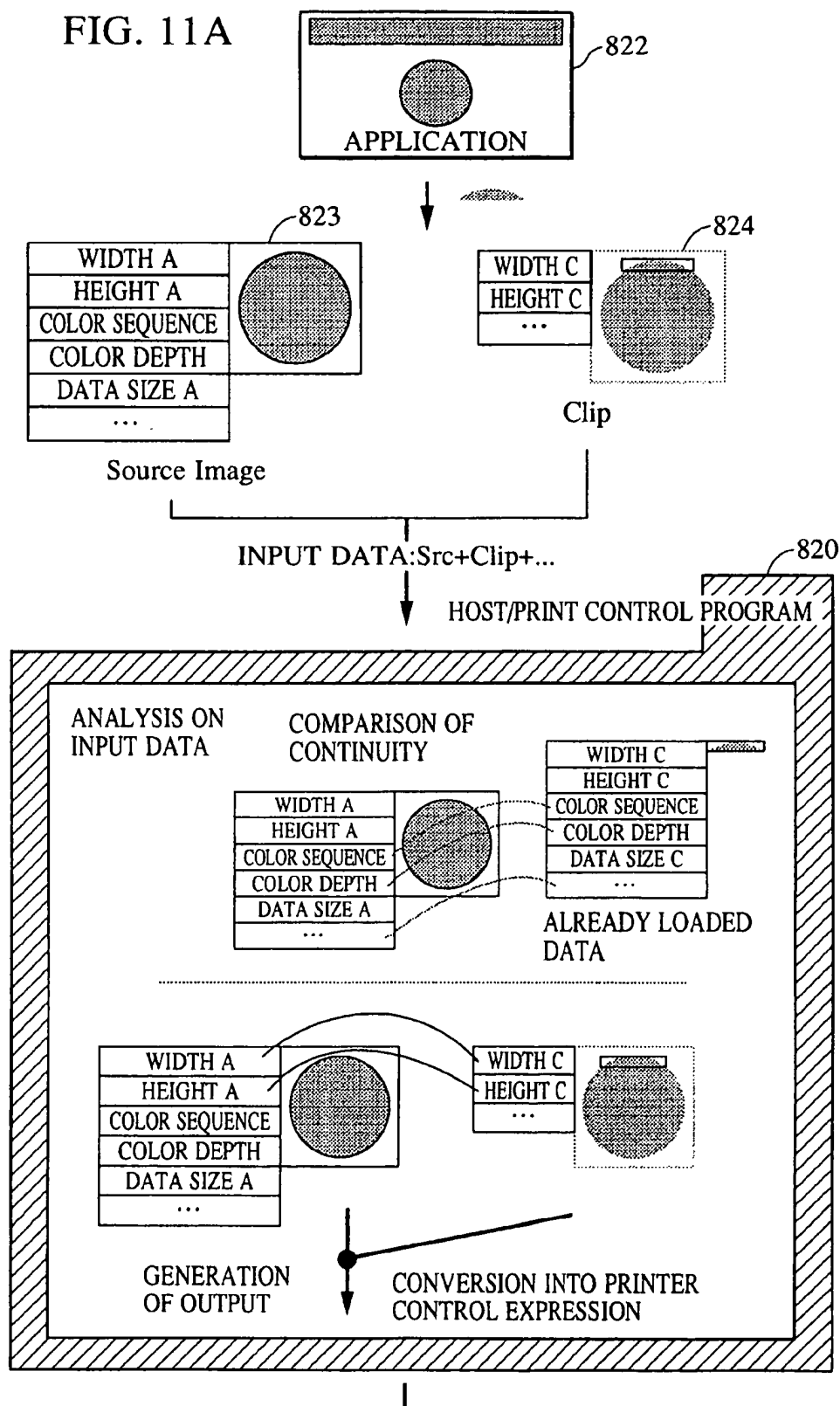


FIG. 11A



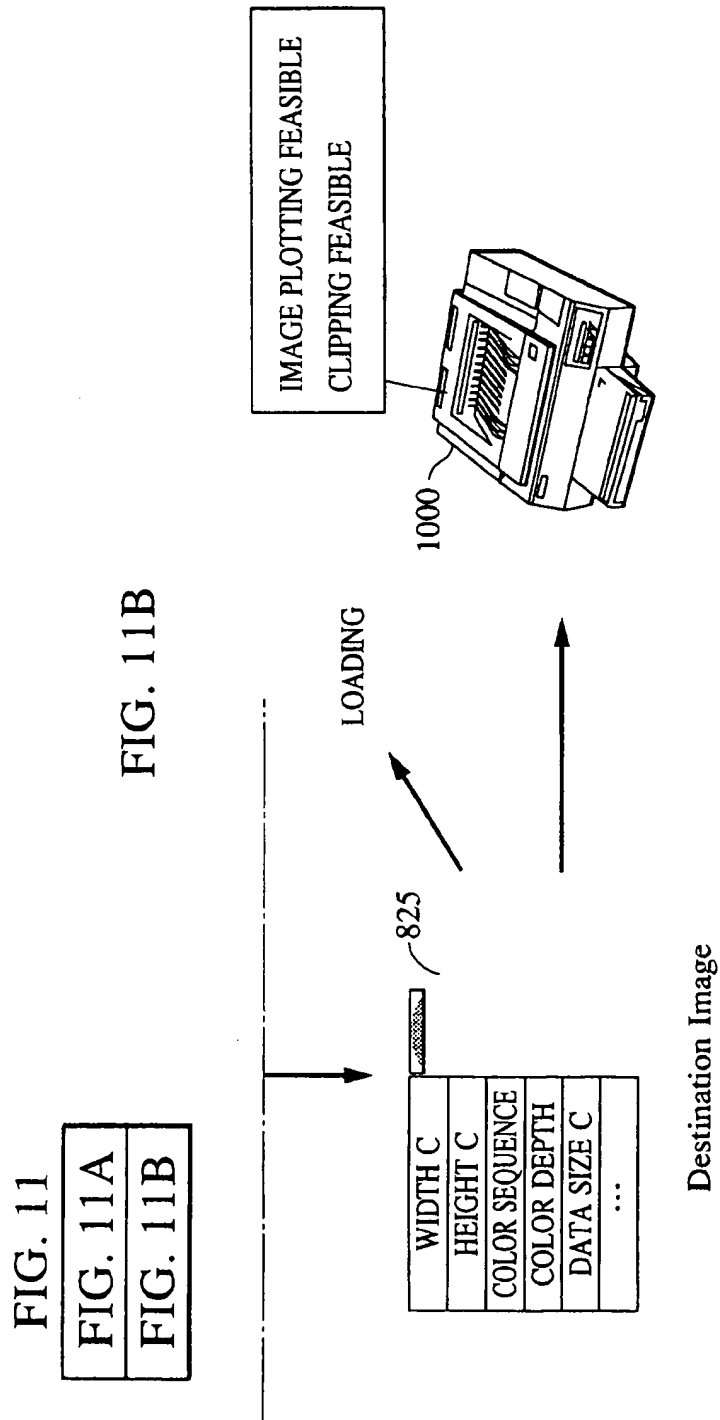


FIG. 12A

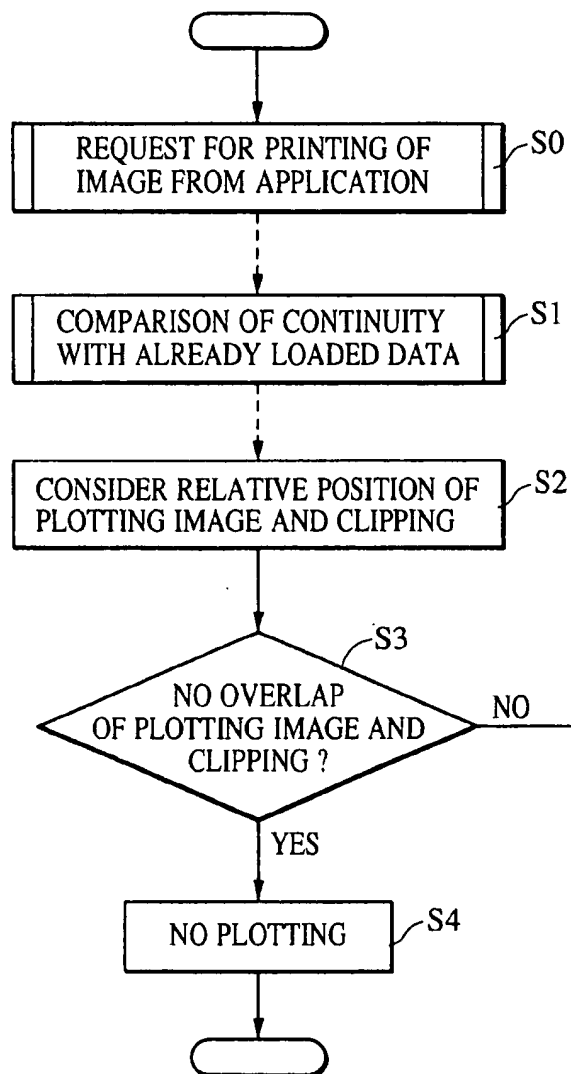
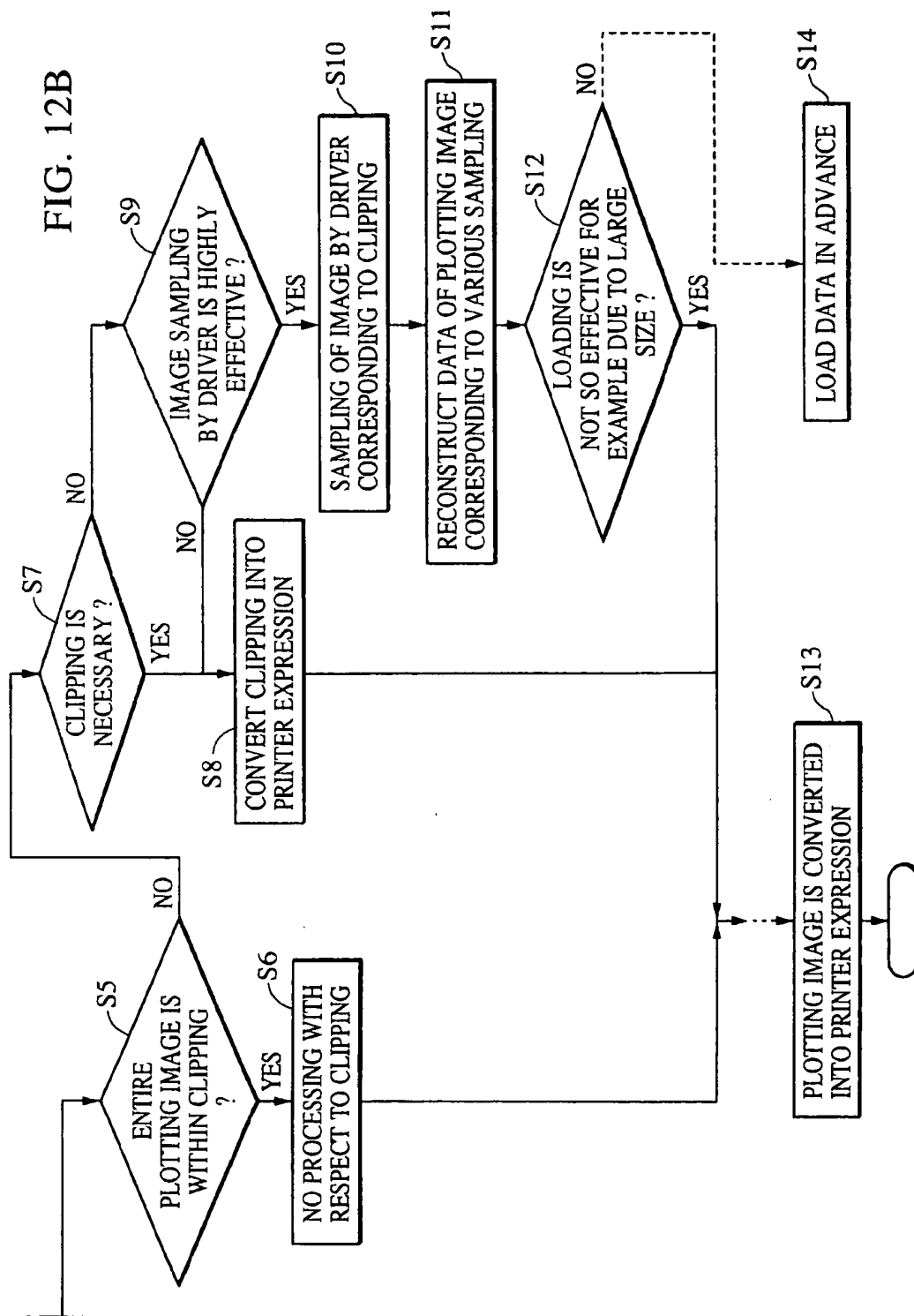


FIG. 12

FIG. 12A

FIG. 12B





# PRINTER CONTROLLING APPARATUS AND METHOD AND RECORDING MEDIUM FOR RECORDING PROGRAM CODE FOR EXECUTING THE SAME

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to printer controlling apparatus and methods for processing print data generated for print output for example by an application program of a host computer and also relates to a recording medium for recording a program code for executing the same.

### 1. Description of the Related Art

Usually, when a document prepared by using an application program is to be printed, a printer driver is driven in accordance with a printing procedure of the application. The printer driver converts the print data into a print command by the driven procedure and transmits it to a printer apparatus. Upon receiving the print command, the printer apparatus sequentially analyzes and executes the received command.

However, the printing procedure of an application program is a characteristic of the application. Some of the newly developed applications with high-level functions are designed to repeat the same plotting process again and again or to divide a figure consisting of a large block into small parts or to combine an enormous number of figures to print an area which will, after all, be plotted as a small figure.

Such print data not only increases the amount of data to be transmitted but also results in a problem that, considering only the printed result, an unnaturally long time period is required due to the fact that the apparatus for processing such data is also greatly loaded.

Furthermore, since only a minimized amount of memory is commonly mounted on a printer apparatus because of a limitation of costs, the plotting operation may become impossible due to a shortage of memory that is necessary to process the plotting data when a great amount of plotting data as described is to be processed.

## SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a printer controlling apparatus and method and a recording medium for recording a program code for executing the same with which the above described problems are solved so that, even when plotting data with a high level of redundancy is generated by an application program to be utilized, it is possible to prevent a requirement for long time period until its output or an occurrence of impossibility of plotting.

To achieve the above object, an image processing apparatus is provided in accordance with the present invention, having a printer control apparatus for processing print data generated for print output by an application program of a host computer, comprising: buffer means for buffering a plurality of plotting data generated by said application; and optimization means for arranging the plurality of plotting data buffered in said buffer means into a single data.

Further, an image processing method according to the present invention includes the steps of: buffering a plurality of plotting data generated by an application program of a host computer; determining whether the plurality of buffered plotting data can be described by one plotting data; and, when determined as capable of being described by one plotting data, converting the plurality of buffered plotting data into one plotting data.

Furthermore, a recording medium according to the present invention stores a program code readable by a computer, said program code comprising:

means for buffering a plurality of plotting data generated for print output by an application program; and optimization means for converting the plurality of buffered plotting data into one plotting data.

Other objects and advantages of the present invention will be more apparent from the accompanying drawings, claims and detailed description below.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side sectional view showing the construction of a laser beam printer of Embodiment 1.

FIG. 2 is a block diagram showing the fundamental construction of a printer apparatus according to Embodiment 1.

FIG. 3 is a flowchart of print control procedure of Embodiment 1.

FIG. 4 is a flowchart of the procedure of plotting shown in Fig. 3.

FIG. 5 is a block diagram showing the fundamental construction of a printer apparatus according to Embodiment 2.

FIG. 6, which consists of FIGS. 6(a)–6(d), illustrates an example of plotting data optimization according to an embodiment.

FIG. 7, which consist of FIGS. 7(a)–7(d), illustrates an example of optimization of plotting data.

FIG. 8 is a block diagram showing the construction of a printer control system according to Embodiment 3.

FIG. 9, which consists of FIGS. 9A and 9B, schematically illustrates an image print processing.

FIG. 10 is a flowchart showing a print control procedure according to Embodiment 3.

FIG. 11, which consists of FIGS. 11A and 11B, schematically illustrates an image print processing characteristic of the present invention.

FIG. 12, which consists of FIGS. 12A and 12B, is a flowchart of an example of optimization processing.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Some preferred embodiments of the present invention will be described below in detail with reference to the accompanying drawings.

Before describing the construction of the present invention, the construction of a laser beam printer (hereinafter referred to as "LBP") to which the present invention may be suitably applied will be described below with reference to FIG. 1. It should be noted that, naturally, the printer to which the present invention is applied is not limited to a laser beam printer and printers using other printing methods may be used.

FIG. 1 is a sectional view showing the internal structure of a laser beam printer suitable for the present embodiment. Referring to FIG. 1, what is denoted by numeral 1000 is the body of a LBP which receives and stores character information (character code) and form information or macro commands supplied from a host computer externally connected thereto and produces corresponding character patterns, form patterns or the like in accordance with these informations to form an image on a recording sheet. An

operation panel 1012 is provided with switches for operation, LED indicators, etc., disposed thereon and a printer control unit 1001 controls the LBP 1000 as a whole and analyzes character information or the like supplied from the host computer. The control unit 1001 mainly converts a character information into a video signal of corresponding character pattern and outputs it to a laser driver 1002. The laser driver 1002 is a circuit for driving a semiconductor laser 1003 and effects ON/OFF switching of a laser beam 1004 emitted from the semiconductor laser 1003 in accordance with the input video signal. The laser 1004 is deflected in a left and right direction by a rotary polygon mirror 1005 and scans over an electrostatic drum 1006. An electrostatic latent image of the character pattern is thereby formed on the electrostatic drum 1006. This latent image is transferred onto the recording paper after its being developed by a developing unit 1007 provided around the electrostatic drum 1006. A cut sheet is used as the recording paper. The cut sheet recording paper is set in a paper cassette 1008 mounted on the LBP and is taken into the apparatus by a feeding roller 1009 and carrier rollers 1010 and 1011 so as to be sent to the electrostatic drum 1006.

FIG. 2 is a block diagram showing the construction of software of LBP 1000 (especially of the control unit 1001) according to the present embodiment. Referring to FIG. 2, a host computer 2000 is connected to the printer apparatus 1000 and outputs to the printer apparatus 1000 a print information consisting of print data and control code. The printer apparatus 1000 is generally constituted by a formatter control section 1100 (provided within the above described control unit 1001), interface 1200, output control section 1300, and printer engine section 1400. The formatter control section 1100 comprises a receiving buffer 1101, a command discriminating section 1102, a command analyzing section 1103, a command executing section 1104, a page memory 1105, and a data format determining section 1106. Further, the command analyzing section 1103 includes an application list 1103a and optimization routine 1103b. The receiving buffer 1101 is a storage means for temporarily retaining print information received from the host computer 2000. The command discriminating section 1102 is to perform discrimination of each print control command, and print data is analyzed at the command analyzing section 1103 in accordance with each command. The command analyzing section 1103 is to perform analysis on each print control command. When an application name which is an application discriminating data is received at the command discriminating section 1102, the application name is sequentially compared with the application list 1103a. The application list 1103a is a table describing application names and contrast between the subject command to be optimized and an optimization routine. When the received application name exists within the application list 1103a, an analysis is made by switching the routine for analyzing commands which are the subject of optimization to a corresponding command analyzing routine in the optimization routine 1103b. The command analyzing section 1103 analyzes print information and thereby converts each print control command into the form of an intermediate code having a format which is more readily processed at the command executing section 1104. The command executing section 1104 executes processing corresponding to each command based on the intermediate code and, for those commands related to plotting and printing, sequentially expands a corresponding pattern into the page memory 1105. On the other hand, when it is determined as a simple bit map at the data format determining section 1106, the image data is expanded into

the page memory 1105 as it is. It should be noted that the formatter control section 1100 is generally constructed by a computer system using CPU, ROM, RAM, etc. The output control section 1300 converts the content of the page memory 1105 into a video signal and transmits it to the printer engine section 1400. The printer engine section 1400 is the section of printing mechanism for forming the received video signal into a permanent visible image on the recording paper. *origin*

The total print control processing procedure in the present embodiment with the printer apparatus constructed as the above will be described below with reference to flowcharts shown in FIGS. 3 and 4. The respective processing steps are indicated by S301 to S308 in FIG. 3 and S401 to S408 in FIG. 4.

FIG. 3 shows the main processing from start to end of operation of the printer apparatus 1000. First, at step S301, print data sent from the host computer 2000 is received and is stocked up in the receiving buffer 1101. Next, the print data stocked in the receiving buffer is read at step S302 and, at step S303, it is determined at the command discriminating section 1102 whether or not the print control command is an application name informing command. If it is an application name informing command, the system proceeds to step S304 where the received application name is sequentially compared with the application list 1103a. It is then determined at step S305 whether or not a corresponding application name exists in the application list. If exists, the command analyzing routine for comparison is switched to an optimization routine at step S306, and the system proceeds to plotting process of step S307. On the other hand, when the command received at step S303 is not an application name informing command or when the application name received at step S305 does not exist in the application list, the system directly proceeds to step S307 where plotting is performed, and it is then determined at step S308 whether a print terminating command (job terminating command) has been received or not or whether print data has ended or not. If it is an end of printing, the printing operation is terminated. If not an end of printing, processing of step S301 and after is repeated.

FIG. 4 explains plotting process (S307) as used in FIG. 3. First, at step S401, it is checked at the command analyzing section 1103 whether data is a paper discharge instruction or not and, if a paper discharge command, the system proceeds to step S406 to perform a corresponding processing. Further, when it is not a paper discharge command at step S401, it is then determined whether or not the analyzed command is a command for expansion to the page memory such as character printing or graphic plotting (step S402) and, if not, the system proceeds to step S405 where processing corresponding to such command is executed. If the system proceeds to step S403 from step S402, an intermediate code in a form more readily processed by executing commands is generated. Upon receiving the intermediate code, an expansion processing to the page memory 1105 is performed at the command executing section 1104 (step S404), and, after completion of expansion processing with respect to one print or plotting command, the system returns to step S302 of FIG. 3 where data analyzing process is repeated. If it is determined as a paper discharge instruction at step S401, the content of the page memory 1105 is output as an image transfer by converting it into a video signal for the printer engine section 1400 at the output control section 1300 (step S406). At the printer engine section 1400, printing is performed by forming the received video signal into a permanent visible image on the recording paper (step S407). The

print control processing for one page is then terminated when the printed result is discharged at step S408.

While the actions of the printer apparatus as a whole have been described, these are the processing accomplished mainly by the computer system of the formatter control section 1100.

#### EMBODIMENT 2

FIG. 5 shows the main processing from start to end of operation of the printer apparatus 1000 of this embodiment. The respective processing steps are indicated by S501 to S509 in FIG. 5. Note that the plotting process in FIG. 5 is similar to that of Embodiment 1 and will not be described.

First, at step S501, print data sent from the host computer 2000 is received and stocked in the receiving buffer 1101. Next, a command chain stocked in the receiving buffer is read out at step S502 and it is determined at step S503 whether a determination on command optimization has been made or not. If a determination on optimization has not yet been made, a characteristic is extracted from the transmitting method of the command chain at step S504. In particular, it is for example a correlation between the respective commands of coordinate parameters, area size, etc. The characteristics extracted at step S505 are then sequentially compared with a list of table corresponding to the application list of Embodiment 1, and it is determined at step S506 whether a matching characteristic exists in the list. If there is a matching characteristic at step S506, the system proceeds to step S507. At step S507, the command processing routine corresponding to the list is switched to the optimization routine and the system then proceeds to plotting process of step S508. On the other hand, when a determination on optimization has already been made at step S503 or when a list with a matching characteristic is not found at step S506, the system directly proceeds to step S508 where plotting is performed and it is then determined at step S509 whether a print terminating instruction has been received or not or whether print data has ended or not. If it is an end of print, the printing operation is terminated. If not an end of print, processing of step S501 and after is repeated.

FIGS. 6 and 7 show an example of optimization of plotting process by the optimization routine (S306, S506). A further description of the optimization routine will be given later with reference to FIG. 12.

For example, as shown in FIG. 6, when a command chain such as one plotting polygons (rectangle) by consecutively shifting coordinates by a small amount at a time (a) has been generated by and transmitted from an application program, the respective polygons are individually plotted (b) by a conventional printer apparatus since the commands are sequentially analyzed and executed. Consequently, an image as indicated by (d) is obtained. In the present embodiment, a characteristic of transmitting by the application is previously recognized so that they are replaced by a command for plotting a single rectangle (c) through the above described optimization routine without affecting the image to be obtained at the end (d).

Further, as shown in FIG. 7, when a command chain such as one plotting the same image data at the same position again and again with changing the area to be clipped has been transmitted (a), a conventional printer apparatus effects a plotting faithfully in accordance with each command chain (b). In this embodiment, they are converted into commands (c) for plotting an image of the area to be clipped through an optimization routine without affecting the image (d) to be obtained at the end. In FIG. 7, of the area for which image data is sent by plotting instruction (the portion of rectangle formed by broken lines in the figure), actual plotting is performed only in the area specified by clipping instruction (the portion of rectangle formed by solid lines in the figure).

While, in the above described Embodiments 1 and 2, the received commands are converted through an optimization routine and then converted into an intermediate code, it is also possible to generate an optimized intermediate code from the received command or to optimize an intermediate code after converting the received command into an intermediate code.

#### EMBODIMENT 3

FIG. 8 is a block diagram for explaining the construction of a printer control system showing Embodiment 3 of the present invention. Here, a description will be given below using the laser beam printer (FIG. 1) as an example. Naturally, as far as the function of the present invention can be executed, the present invention may be applied to any of a single equipment, a system consisting of a plurality of equipments or a system in which data is processed through a network such as LAN.

Referring to FIG. 8, what is denoted by numeral 3000 is a host computer, which includes a CPU 1 for executing a document processing where pattern, image, character, table (including listing or the like), etc., are mixed based on a document processing program stored in a program ROM of ROM 3, the CPU 1 generally controlling the devices connected to a system bus 4. The program ROM of the ROM 3 stores a control program or the like of CPU 1, font ROM of the ROM 3 stores font data or the like to be used in the above document processing, and data ROM of the ROM 3 stores various data to be used in performing the above document processing, etc. RAM 2 functions as a main memory of CPU 1, work area, etc. A keyboard controller (KBC) 5 controls key input from a keyboard 9 or a pointing device (not shown). A CRT controller (CRTC) 6 controls display on a CRT display (CRT) 10. Memory controller (MC) 7 controls access to an external memory 11 such as a hard disk (HD) or floppy disk (FD) for storing a boot program, various applications, font data, user file, edit file, etc. A printer controller (PRTC) 8 is connected to a printer 1000 through a predetermined bidirectional interface 21 to execute communication control processing with the printer 1000. It should be noted that the CPU 1 executes expansion (rasterize) processing of outline font onto a display information RAM provided for example on RAM 2 so as to make WYSIWYG on the CRT 10 possible. Further, the CPU 1 opens various windows entered based on commands directed by a mouse cursor or the like (not shown) on the CRT 10 to execute various data processing. In the printer 1000, a printer CPU 12 generally controls access with various devices connected to a system bus 15 based for example on a control program stored in the program ROM of ROM 13 or a control program stored in an external memory 14 and outputs an image signal as an output information to a printing section (printer engine) 17 which is connected thereto through a printing section interface 16.

Further, a control program or the like of CPU 12 as shown in a flowchart of Embodiment 1 or 2 can be stored to the program ROM of ROM 13.

Font data or the like to be used in generating the above output information is stored to the font ROM of ROM 13, and, in the case of a printer without the external memory 14 such as a hard disk, information or the like for use on the host computer is stored to the data ROM of ROM 13. CPU 12 is capable of communication processing with the host computer through an input section 18 and is constructed so that information or the like within the printer can be given to the host computer 300. What is denoted by numeral 19 is a RAM which functions as a main memory, work area, etc. of CPU 12 and is constructed so that memory capacity thereof can be extended by an optional RAM connected to an extension port (not shown). It should be noted that the

RAM 19 is used for example as an output information expansion area, environment data storage area, NVRAM, etc. Access to the external memory 14 such as the above described hard disk (HD) or IC card is controlled by a memory controller (MC) 20. The external memory 14 is connected as an option and stores font data, emulation program, form data, etc. What is denoted by numeral 18 is the above described operation panel and has switches for operation and LED display indicator, etc., disposed thereon. The number of the above described external memory is not limited to one. At least one unit is provided and it may also be constructed such that a plurality of optional font card in addition to internal font or of external memory for storing program to interpret a printer control language of a different language system can be connected thereto. Furthermore, an NVRAM (not shown) may also be provided so as to store a printer mode setting information from the operation panel 1012.

Next, in a printing system constructed as the above, FIG. 9 summarizes an ordinary image print processing. The printer 1000 is capable of both plotting and clipping an image. An example is shown here of the case where printing of an image from an application program of a host computer is effected with such printer 1000. First, an output object represented for example by an image plotting command 813 or clipping command 814 from the application is delivered. A host/print control program (printer driver) 810 converts the object into a control representation of the printer. The printer driver 810 is provided by FD or the like or stored in HD in advance. Since, as described above, the printer 811 is capable of both image plotting and clipping, the image plotting command 813 or clipping command 814 requested for printing by the application 812 is transmitted to the printer in a manner converted into an image plotting command 815 or clip command 816 of a control representation of the printer. Printing is then effected at the printer 1000.

In this embodiment, the optimization of plotting process in Embodiment 1 and Embodiment 2 is performed on the host computer side in accordance with the printer driver 810. The print control processing procedure as a whole in the present embodiment will now be described with reference to the flowchart shown in FIG. 10. The respective processing steps are indicated by S801 to S808 in FIG. 10.

FIG. 10 shows main processing from start to end of printing of the host computer 3000. First, at step S801, plotting data is received from an application program, and the plotting data is first buffered at step S802. Next, it is determined at step S803 whether or not the data is of the kind to which an optimization should be applied. If determined as the kind of data to be optimized, it is further determined at step S804 whether repetition of the same command chain has been terminated or not and whether buffering has been repeated up to a threshold or not. If negative results are obtained for the both, processing of step S801 and after is repeated. If repetition of the same command chain has been terminated or if buffering has been repeated up to a threshold at step S804, optimization processing is performed at step S805. The optimization processing will be described later. Thereafter, the optimized data is converted into a printer command at step S806. On the other hand, if it is determined at step S803 not as data to which an optimization should be applied, the system directly proceeds to step S806 where data is converted into printer command and it is then transmitted to a printer apparatus at step S807. Thereafter, the system proceeds to step S808 where it is determined whether plotting data from application has ended. If an end of plotting data, plotting is terminated. If not an end of plotting data, the system returns to step S801 and processing is repeated accordingly.

Next, a generalized example of optimization in an image print processing is shown in FIG. 11 and is effected in such

a manner as to replace those of large width by those of clip. Further, conversion into a printer control expression is not immediately performed at this point; an extraction of the image is performed so as to retain it as it is in the form of input data. A comparison of continuity is made at a point in time when this output routine is next called (pallet, color depth, plotting position, etc.). If there is no continuity, it is output as converted into a printer control expression. If there is a continuity, however, loading is repeated. As a result, a plotting image 825 in the form of printer control expression is obtained. The clipping object is not directly converted into a printer control expression.

While, in Embodiment 1, an application name is transmitted to the printer apparatus, a different signal may be used as far as it is a type of trigger capable of switching processing.

Further, in Embodiment 1, a table is internally provided to previously retain as an information on the characteristics of data transmission of a plurality of application programs. If, however, the number of targeted applications is small, it is also possible to determine whether an optimization should be effected or not without having a table.

Similarly, while, in Embodiment 2, the flowchart thereof is shown in FIG. 12.

Similarly to FIG. 9, the printer 1000 is capable of both plotting and clipping of an image. An example is shown here of the case where printing of an image is effected with such printer 1000 from an application 822 of a host computer. First, upon a request for printing an image from an application, an output object represented such as by an image plotting command 823 or clip command 824 is delivered. The host/print control program (printer driver) 810 converts the object into a control expression of the printer. In the case shown in FIG. 11, the clipping area of the clip command 824 corresponds to only a small portion of the image plotting area of the image plotting command 823. The host/print control program 810 makes a comparison of attributes between the plotting image and the clip object and is capable of determining that the clip is significantly smaller as shown in the figure. In this case, if a method is employed of effecting clipping at the computer and then plotting a plotting image, most of the plotting image data do not affect the plotting result but are to be transmitted to the printer 1000. Then, at the time of conversion into printer control expression, only the area corresponding to the clip is extracted from the image and conversion into control expression of the printer is characteristics of command chain are provided in a table, it is also possible to make a decision on an optimization without using a table.

In Embodiment 3, an optimization is treated as a single operation when command chains are being repeated. In the case where the application name is previously known, however, it is also possible to buffer a plurality of command chains according to the characteristic of the application to perform a plurality of optimization processing.

As has been described above, according to the present invention, a redundant print data is optimized according to the characteristics of the print data so that an efficient plotting process is achieved and a high speed printing becomes possible. Further, since memory required by the printer apparatus can be saved, an impossibility of plotting due to memory shortage can be prevented and it is possible to lower the product cost.

What is claimed is:

1. An image processing apparatus for processing output data generated for image output by an application on a host computer, said image processing apparatus comprising:

buffer means for buffering a plurality of plotting data instructions generated by the application program; and

optimization means for arranging the plurality of plotting data instructions buffered by said buffer means into one plotting data instruction.

2. A printer apparatus comprising an image processing apparatus for processing output data generated for image output by an application on a host computer, said image processing apparatus comprising:

buffer means for buffering a plurality of plotting data instructions generated by the application program; and

optimization means for arranging the plurality of plotting data instructions buffered by said buffer means into one plotting data instruction.

3. A host computer comprising an image processing apparatus for processing output data generated by an application on said host computer for image output to a printer apparatus, said image processing apparatus comprising:

buffer means for buffering a plurality of plotting data instructions generated by the application program; and

optimization means for arranging the plurality of plotting data instructions buffered by said buffer means into one plotting data instruction.

4. An image processing apparatus according to claim 1, further comprising means for determining whether said optimization means is to be used or not by a type of the application program.

5. An image processing apparatus according to claim 1, further comprising:

means for extracting characteristics of the plurality of plotting data instructions; and

means for determining whether said optimization means is to be used or not based on the extracted characteristics.

6. An image processing apparatus according to claim 4, wherein said means for determining uses application discriminating data and a table of plotting commands and optimization routines.

7. An image processing apparatus according to claim 1, wherein said optimization means uses a table of plotting commands and optimization routines.

8. An image processing apparatus according to claim 1, wherein said optimization means converts a first plotting data instruction and a second plotting data instruction into a third plotting data instruction, the first plotting data instruction containing a plotting instruction and position data of image data to be plotted and the second plotting data instruction containing a clipping instruction and area data to be clipped.

9. An image processing apparatus according to claim 8, wherein, when a clipping area to be clipped defined by the area data is within a plotting area of the image data, said optimization means effects a conversion such that the third plotting data instruction contains image data within the clipping area, a plotting instruction of the image data and position data indicating the clipping area.

10. An image processing apparatus according to claim 1, wherein said optimization means converts a plurality of plotting data instructions containing respective painting instructions and area data to be painted into a plotting data instruction containing area data synthesizing the painting instructions and the area data.

11. An image processing method comprising the steps of: buffering a plurality of plotting data instructions generated for image output by an application program of a host computer;

determining whether or not the plurality of buffered plotting data instructions can be described by a single converted plotting data instruction;

and when it is determined that the plurality of buffered plotting data instructions can be described by a single converted plotting data instruction, converting the plurality of buffered plotting data instructions into the converted plotting data instruction.

12. An image processing method according to claim 11, further comprising the step of printing based on the converted plotting data instruction.

13. An image processing method according to claim 11, further comprising the step of outputting the converted plotting data instruction to a printer.

14. An image processing method according to claim 11, said determining step determines whether said converting step is to be effected or not by a type of the application program.

15. An image processing method according to claim 11, further comprising the steps of:

extracting characteristics of the plurality of plotting data instructions; and

determining whether said converting step is to be effected or not based on the extracted characteristics.

16. An image processing method according to claim 14, wherein a determination in said step of determining is made using application discriminating data and a table of plotting commands and optimization routines.

17. An image processing method according to claim 11, wherein said converting step uses a table of plotting commands and optimization routines.

18. An image processing method according to claim 11, wherein in said step of converting, a first plotting data instruction and a second plotting data instruction are converted into a third plotting data instruction, the first plotting data instruction containing a plotting instruction and position data of image data to be plotted and the second plotting data instruction containing a clipping instruction and area data to be clipped.

19. An image processing method according to claim 18, wherein, when a clipping area to be clipped defined by the area data is within a plotting area of the image data, said step of converting effects a conversion such that the third plotting data instruction contains image data within the clipping area, a plotting instruction of the image data and position data indicating the clipping area.

20. An image processing method according to claim 11, wherein said step of converting converts a plurality of plotting data instructions containing respective painting instructions and area data to be painted into a plotting data instruction containing area data synthesizing the painting instructions and the area data.

21. A computer readable medium which, when inserted into a programmable apparatus, causes said apparatus to execute an image processing method comprising the steps of:

buffering a plurality of plotting data instructions generated for image output by an application program of a host computer;

determining whether or not the plurality of buffered plotting data instructions can be described by a single converted plotting data instruction; and

when it is determined that the plurality of buffered plotting data instructions can be described by a single converted plotting data instruction, converting the plurality of buffered plotting data instructions into the converted plotting data instruction.

\* \* \* \* \*

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 5,832,192

DATED : November 3, 1998

INVENTOR(S) : YASUHIRO HINO

Page 1 of 2

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

COLUMN 7

Line 67, "a effected" should read

--a flowchart thereof is shown in Fig. 12.

¶ Similarly to Fig. 9, the printer 1000 is capable of both plotting and clipping of an image. An example is shown here of the case where printing of an image is effected with such printer 1000 from an application 822 of a host computer. First, upon a request for printing an image from an application, an output object represented such as by an image plotting command 823 or clip command 824 is delivered. The host/print control program (printer driver) 810 converts the object into a control expression of the printer. In the case shown in Fig. 11, the clipping area of the clip command 824 corresponds to only a small portion of the image plotting area of the image plotting command 823. The host/print control program 810 makes a comparison of attributes between the plotting image and the clip object and is capable of determining that the clip is significantly smaller as shown in the figure. In this case, if a method is employed of effecting clipping at the computer and then plotting a plotting image, most of the plotting image data do not affect the plotting result but are to be transmitted to the printer 1000. Then, at the time of conversion into printer control expression, only the area corresponding to the clip is extracted from the

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It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

COLUMN 7

image and conversion into control expression of the printer is effected--.

COLUMN 8

Line 22, "flowchart thereof" should be deleted.

Lines 23-44 should be deleted.

Line 45, "expression of the printer is" should be deleted.

Signed and Sealed this  
Fifth Day of October, 1999

Attest:



Q. TODD DICKINSON

Attesting Officer

Acting Commissioner of Patents and Trademarks